The Welding Engineer

Edited by L. B. Mackenzie

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AIRCO DAVIS APPARATUS

ANYTHING AND EVERYTHING
FOR OXYACETYLENE WELDING AND CUTTING

Public faith in a product is a reflection of faithful performance. Thus, consistently, have Airco Oxygen and Airco Acetylene built up good-will.

AIR REDUCTION SALES COMPANY

Manufacturer of Airco Oxygen—Airco Acetylene—Airco-Davis-Bournonville Welding and Cutting Apparatus and Supplies, Acetylene Generators, and Specially Designed Machines for Automatic Welding and Cutting—Nitrogen, Argon and other Airco Atmospheric Gas Products

Controls the manufacture and sale of National Carbide

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Airco District Offices, Plants and Distributing Stations conveniently located throughout the country.

Air Reduction Sales Co. maintains its own Apparatus Repair Shops in Airco District Office cities.

"Airco Oxygen and Acetylene Service is Good Service."

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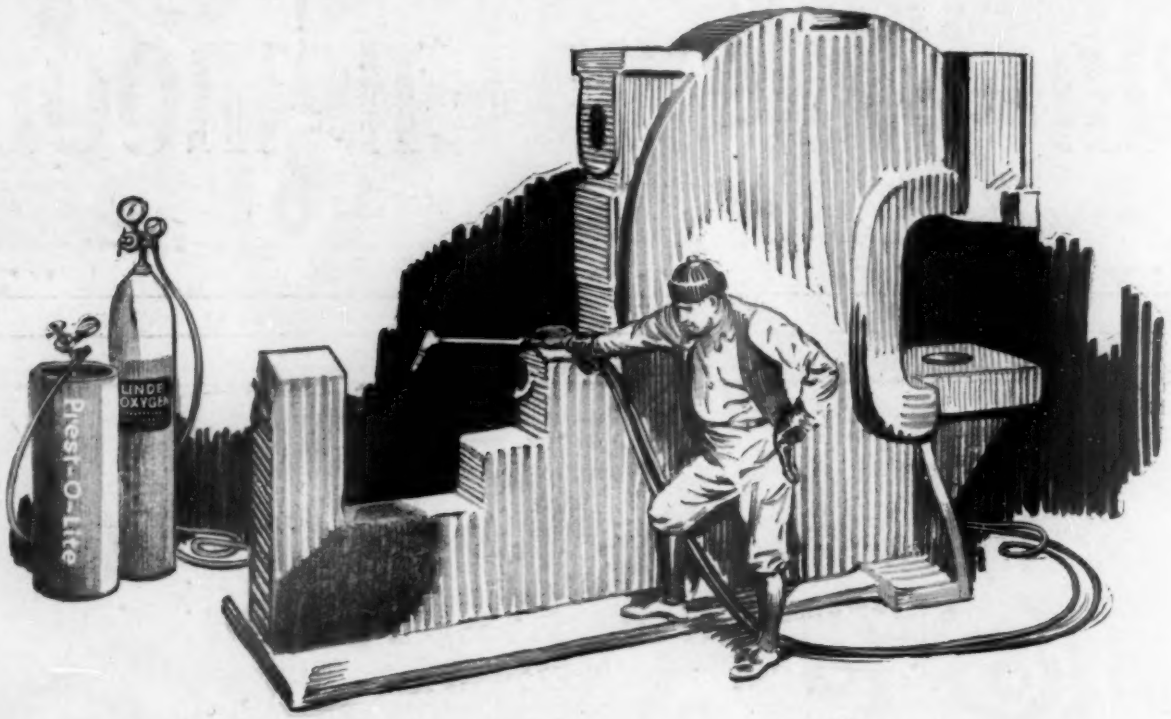

Salvaging $1800.00 worth of gray iron and labor!

When this great 16 ton punch press frame was taken from the sand it proved defective.

True it could be broken up and recast, saving much of the metal, but the loss in time and money would still be a large item.

The Oxwelding torch solved the problem—as it so often does. The casting was properly preheated and two skilled operators were then set to work. No less than 200 pounds of No. 9 cast iron rods were used as a filler. In just 12 hours the job was done!

It was absolutely satisfactory, and, to the gratification of the owners, the cost was but a small fraction of the expense of duplication—not to mention time saved.

Are YOU making full use of oxy-acetylene possibilities in repair and reclamation? Oxweld Resident Engineers in more than fifty cities will gladly help on your welding and cutting problems. Send for illustrated book "Oxweld Can Do It."

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Newark, N. J. Chicago San Francisco

Oxweld

WELDING AND CUTTING APPARATUS

WORLD'S LARGEST MANUFACTURERS OF WELDING AND CUTTING EQUIPMENT

Welding and Cutting Torches

Unequalled in construction
Unsurpassed in performance

Flash Back

A "FLASH-BACK" is the establishment of a stable flame within the mixing chamber of a torch due to the striking back of the flame into the orifice of the tip.

A "BACK-FIRE" differs from a flash-back in that the flame does not continue within the interior of the torch but is extinguished and the mixed gas again issues from the tip in the normal manner and is re-ignited by the hot metal.

An oxy-acetylene flame is propagated in the open at a rate of several hundred feet per second. In a confined space this value may rise to several thousand feet per second.

The normal flame will not enter the orifice of a properly designed tip against the flow of gas. However, the flow of gas may be retarded by touching the tip of the metal or sparks may enter the orifice of the tip and start a high velocity flame or detonation.

It is impossible, or at least impractical, to provide a velocity of gas flow that will force out a high velocity flame. Therefore it is not possible to prevent back-fires.

The ease with which a torch will back-fire depends upon the design and workmanship on the tip and the gas velocity.

Purox torches are not easily back-fired and they accomplish this result through tip design rather than resorting to a hard flame.

The mixer and mixing chamber are proportioned so that the pressure developed in the event of a back-fire is used to control the flow of oxygen and acetylene in such a way that the flame is extinguished.

Purox torches withstand extremely severe abuse without a flash back and when operated with ordinary skill Purox torches are entirely free from the resultant loss of time and annoyance.

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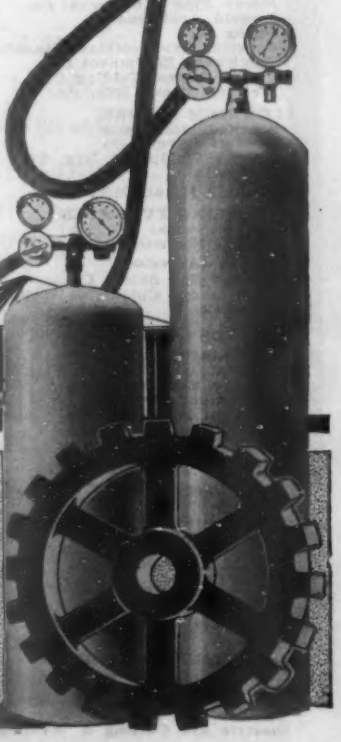

WELDING
PUROX
CUTTING

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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Purox Co.
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United States Welding Co.
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BLOW TORCHES (Acetylene)
See "Torches"

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The Welding Engineer
Electric Arc Cutting & Welding Co.

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We not only do welding, but supervise the design and installation of oxy-acetylene welding plants; report on welding material and methods; make tests on welding apparatus for efficiency and economy.

Nine years' experience.

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Purox Co.
Smith's Inventions, Inc.
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Burdett Oxygen Co.
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Purox Co.
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United States Welding Co.

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U. S. Welding Co.
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See "Torches"

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Chicago Steel & Wire Co.
Wm. Cramp & Sons
Davis-Bournonville Co.
Electric Arc Welding & Cutting Co.
International Oxygen Co.
Modern Engineering Co.
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Oxweld Acetylene Co.
Purox Co.
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Welding Metals Mfg. Co.

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WORN rails, switch points, etc., can best be built up to their original condition with Page High Carbon Welding Wire. Hardness tests point convincingly to the fact that surfaces welded with Page High Carbon Steel offer wearing qualities more than equal to the original metal. You will find that Page High Carbon Welding Wire contributes appreciably to the economy of track maintenance.

Page High Carbon Welding Wire is recommended for building up other High Carbon steel parts such as Steel Tires, Buffers, etc.

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Wm. Cramp & Sons
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Modern Engineering Co.
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Purox Co.
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United States Welding Co.

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Carbic Mfg. Co.
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Universal Oxygen Co.
Wm. Cramp & Sons
Davis-Bournonville Co
International Oxygen Co.
The Imperial Brass Mfg. Co.
Modern Engineering Co.
Purox Co.
Oxweld Acetylene Co.
Reid-Avery Co.
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Superior Oxy-Acetylene Machine Co
United States Welding Co.

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FLUXES
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Purox Co.
Smith's Inventions, Inc.
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Purox Co.
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Welding Metals Mfg. Co.

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Modern Engineering Co.
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Purox Co.
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Modern Engineering Co.
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Purox Co.
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K-G Welding & Cutting Co.
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Torchweld Equipment Co.
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International Oxygen Co.
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WORLD'S BEST QUALITY—HIGHEST GAS YIELD

ALWAYS PACKED IN BLUE AND GRAY DRUMS

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For Oxy-Acetylene Welding and Cutting Plants, Acetylene House Lighting and Cooking Plants, Contractors' Torches and Flare Lights, and numerous other pieces of Acetylene generating apparatus designed for the use of one of these sizes of Carbide.

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Monmouth.....61½ Public Square
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Springfield.....1301 Washington St.
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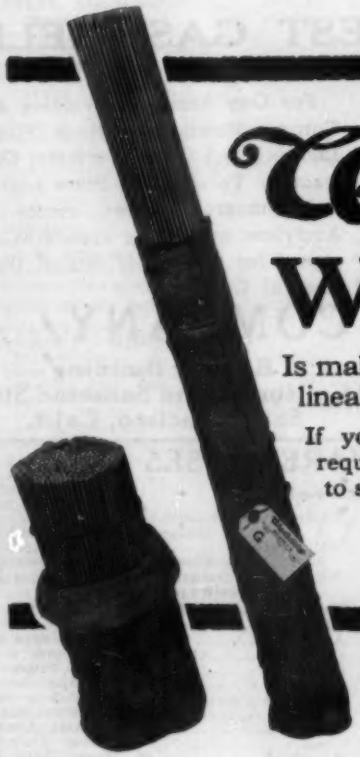

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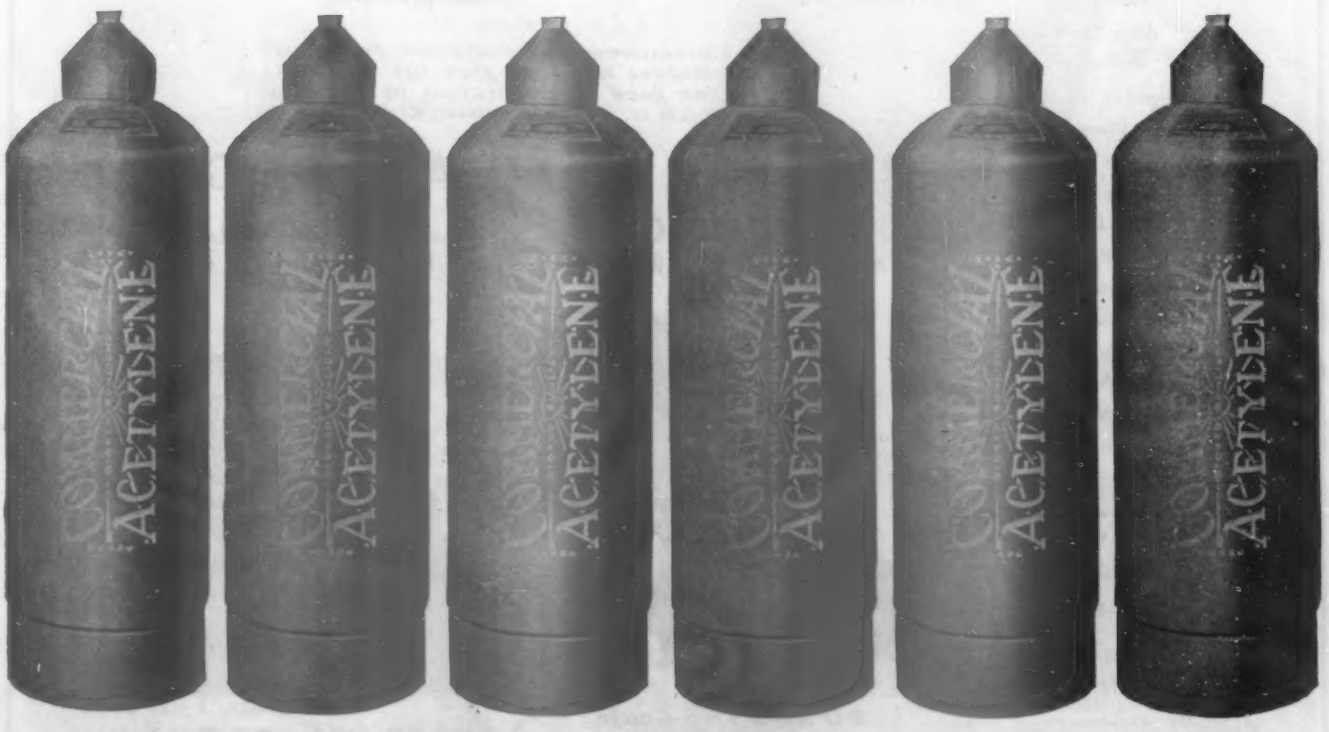

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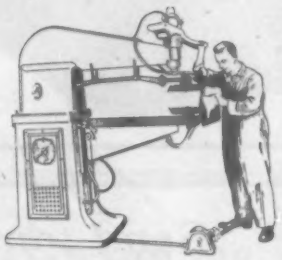

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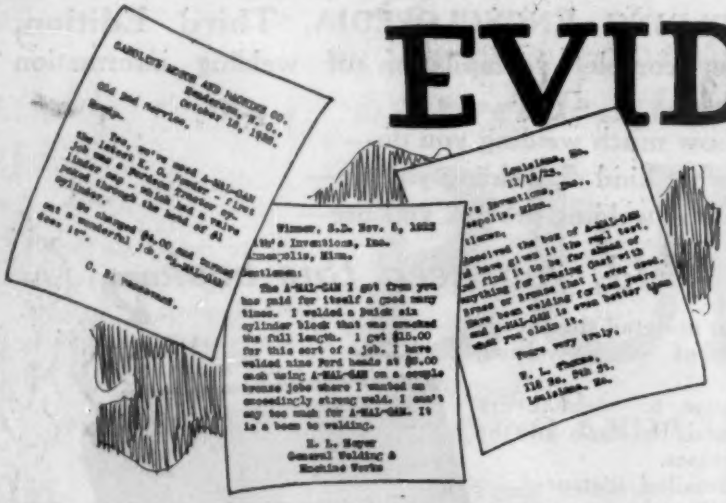

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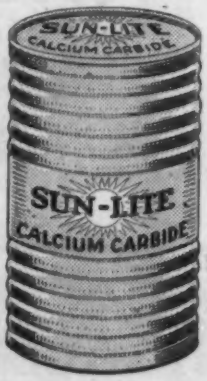

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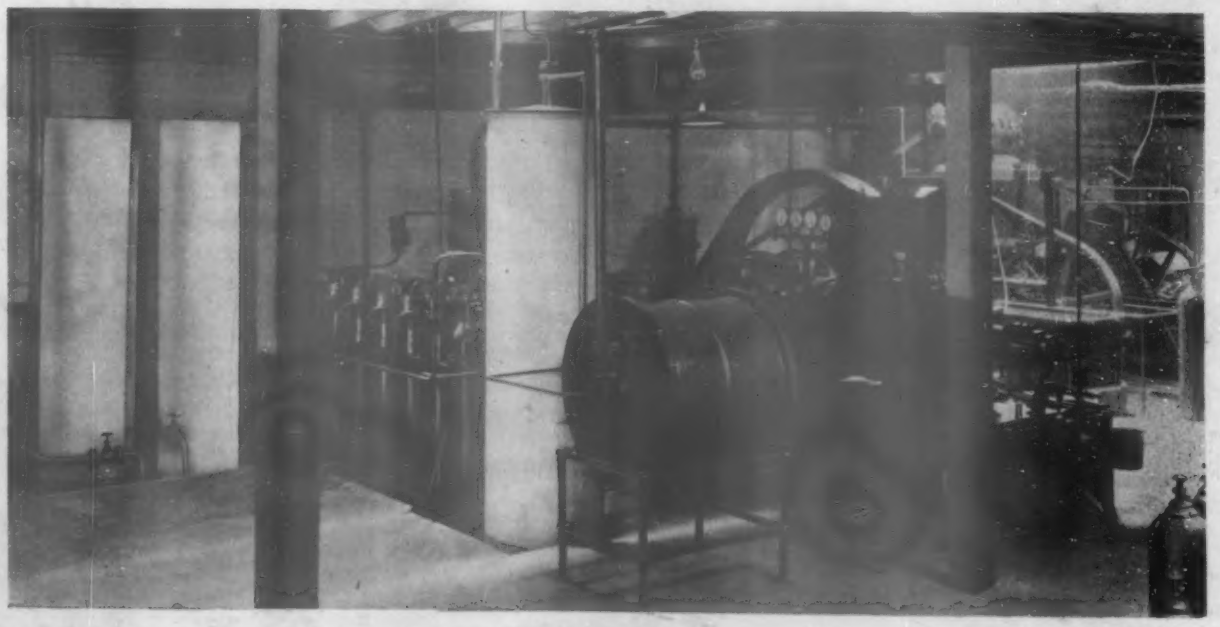

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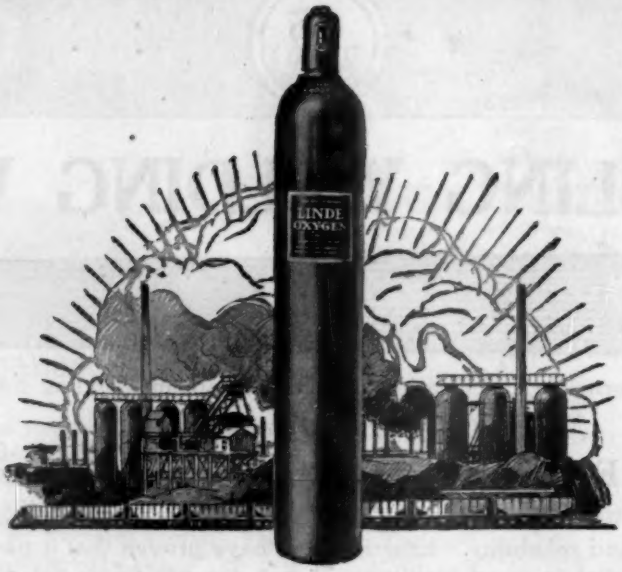

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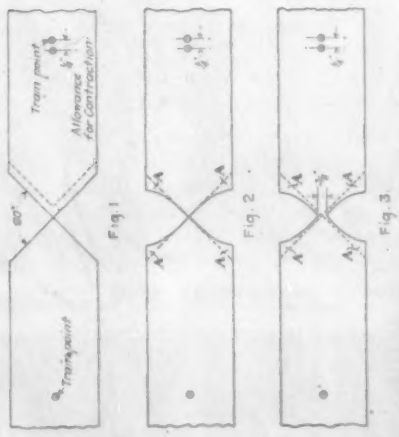
LINDE OXYGEN

Welding in Locomotive Repair Shops*

Particulars Regarding the Various Oxy-Acetylene Welding Operations Employed in Locomotive Repair Shops

By Fred E. Rogers†

LOCOMOTIVE maintenance and general repairs have undergone considerable change in method within the past decade as a result of the introduction of the newer welding processes. It is indeed fortunate for transportation interests that gas, electric, and thermit welding have become available. If old-time railwayshop practice had prevailed during the shopmen's strike in 1922-1923, the numbers of locomotives out of service on the railways affected would have been still greater than they were. Welding has taken great strides forward. A recent survey of locomotiveshop practice, made by a railway service engineer on one of the large railway systems, showed over one hundred welding operations practiced in locomotive repair work. This survey, made in the interest of oxy-acetylene welding only, does not include those operations which were considered as being better fitted perhaps for the electric-arc or the thermit process.



Figs. 1 to 3—Methods of Preparing Frame Welds.

Fig. 4—Frame Preparation Requring a Piece to be Cut Out to Remove Defective Material.

Fig. 5—Frame Shown in Fig. 4 After Being Welded.

The intelligent and honest welding engineer frankly concedes that the particular welding process which he represents may be at a disadvantage in certain cases with other processes, considering cost, feasibility, or application. There is plenty of room for the development and use of each, and the best interests of all concerned are conserved by recognizing the advantages and limitations of any particular process. This paper is not offered as an argument for oxy-acetylene welding only because the author is interested in promoting gas welding, but is simply an endeavor to point out in an unprejudiced way how the officials responsible for locomotive maintenance have profitably employed gas welding (oxy-acetylene) in locomotive repair work. What has been done and is being done by an increasing number of railway systems, can be done with equal benefit by all.

Locomotive Parts Repaired by Oxy-Acetylene Welding

Following is a list of locomotive parts that are repaired by oxy-acetylene welding. This list by no means comprehends all. On the other hand, it includes some parts that under certain conditions should not be repaired by gas welding or by any other welding process. It is a well-known fact that many machine parts can be replaced with new at a cost less than that of the repair of worn parts. This applies to some locomotive parts in principle, but owning to the multiplicity of types and lack of interchangeability, there are few repair shops having storerooms from which they can draw new parts for all minor repair jobs to which this general statement might apply. Hence, in many cases, repairs are made because the new parts could not be obtained without laying up the locomotive for several extra days.

List of Locomotive Parts Repaired by Oxy-Acetylene Welding

Air-brake cylinders, broken and welded
Air-brake pistons, worn part built up
Air-reservoir heads, welded in
Air-reservoir brackets, broken and welded
Air-pump valve housings, welded
Air-pump heads
Air-pump cylinders
Air-pump lugs
Air-pump brackets
Air-pump piston, built up
Ashpan castings, broken and welded
Ashpan corners, welded
Binders, built up and welded
Brake hangers, holes welded; and broken and welded
Brake-hanger pins, built up
Brake adjusters, broken and welded
Brake beams, ends built up
Bells, cracked and welded
Bell stands, broken and welded
Branch pipes, brazed; broken and welded
Brake-rod jaws, broken and welded; holes welded
Back-head patches, welded
Couplers, welded
Coupler pockets, broken and welded; cracked and welded
Coupler knuckles, worn part built up
Cylinders, welded
Cylinder heads, welded
Crossheads, pin fits, welded
Crosshead lateral, welded
Crosshead piston fit, worn part built up
Crosshead cracks, welded
Casing-sheet patches, welded
Cast-steel tank frames, broken and welded; cracked and welded
Cast-steel truck frames, broken and welded, cracked and welded
Driving boxes, broken and welded; cracked and welded
Driving-box collars, broken and welded; cracked and welded

†*Air Reduction Sales Co.*

**Paper presented at the Chattanooga Regional Meeting of the Southern Local Section of the American Society of Mechanical Engineer, Chattanooga, Tenn., October 23 and 24, 1923.*

Driving-wheel spokes, broken and welded; cracked and welded
Driving-wheel tires, built up (sharp flanges and flat spots)
Door-sheet patches, welded
Drawbar pockets, broken and welded; cracked and welded
Dry-pipe joints, brazed

Engine-truck frames, broken and welded; cracked and welded
Engine-truck boxes, broken and welded; cracked and welded
Engine-truck cradle hangers, broken and welded; worn part built up
Engine-truck radius bars, broken and worn; worn part built up
Engine-truck pedestals, worn part built up
Eccentrics, worn part built up
Eccentric straps, broken and welded; worn part built up
Eccentric blades, worn part built up
Equalizer brackets, broken and worn
Front-end deck castings, broken and welded; cracked and welded; worn part built up
Front-end pilot-beam braces, broken and welded; cracked and welded
Frames, broken and welded; cracked and welded
Frame braces, broken and welded; cracked and welded
Front-end steam pipes, broken and welded; cracked and welded
Front-end nozzle stands, broken and welded; cracked and welded
Front-end nigger heads, broken and welded; cracked and welded
Fire doors, broken and welded; cracked and welded
Fire-door levers, broken and welded; cracked and welded
Fire-door frames, broken and welded; cracked and welded
Flue-sheet patches, welded
Fire-door collars and patches, welded
Fire-door ring castings, broken and welded; cracked and welded

Fire-door latches, broken and welded; cracked and welded
Guides, built up.
Guide yokes, broken and welded; cracked and welded
Guide blocks, worn parts built up
Grate bearings, broken and welded; cracked and welded
Grate-shaker bracket, broken and welded; cracked and welded

Half-casing sheets, welded
Handrail posts, broken and welded

Injector valve seats, worn part built up
Injector bodies, cracked and welded
Injector delivery pipes, collars brazed

Lubricators, cracked and welded

Mud-ring corner patches, welded
Mud rings, built up
Main and side rods, grease cups welded on rods

Pilot beams, broken and welded; cracked and welded
Pilot braces, broken and welded
Piston heads, cracked and welded; built up with bronze bottom sector, one-third for wear
Piston fits, built up
Piston-rod-extension guides, broken and welded; cracked and welded; worn part built up
Pedestals, built up

Rocker arms, broken and welded; cracked and welded
Rear deck castings, broken and welded; cracked and welded
Reverse levers, broken and welded; cracked and welded
Reverse-lever latches, broken and welded; cracked and welded
Reverse-lever quadrants, broken and welded; cracked and welded

Reverse-lever reach rods, broken and welded; cracked and welded
Running-board steps, broken and welded; cracked and welded
Running-board brackets, broken and welded; cracked and welded

Smokestack and saddles, broken and welded; cracked and welded
Spring bearings, worn part built up
Spring hangers, worn part built up
Spring saddles, worn part built up
Spring bands, welded when made new
Stoker parts, broken and welded; cracked and welded
Standpipes, broken and welded; cracked and welded
Superheater units, welded
Superheater flues, safe ends and pits, welded
Superheater headers, broken and welded; cracked and welded
Side sheets, welded
Side-rod straps, built up
Slide valves, broken and welded; cracked and welded; worn part built up
Sand-box castings, broken and welded; cracked and welded

Throttle stems, broken and welded; cracked and welded; worn part built up
Throttle brackets, broken and welded; cracked and welded; worn part built up
Throttle-lever latches, built up
Throat-knuckle patches, welded
Truck bolsters, broken and welded; cracked and welded
Truck oil boxes, broken and welded; cracked and welded
Truck pedestals, worn part built up
Throttle-lever quadrants, broken and welded; cracked and welded; worn part built up
Tail bars, built up
Truck center castings, broken and welded; cracked and welded.

Boiler Welding

Welding boiler side sheets, flue sheets, tubes, and mud rings and boiler welding in general will not be discussed in this paper for several reasons: It is a big subject sufficient for one paper alone. Vital matters of safety are involved, too important for full discussion here. Rulings of the Interstate Commerce Commission in regard to boiler welding

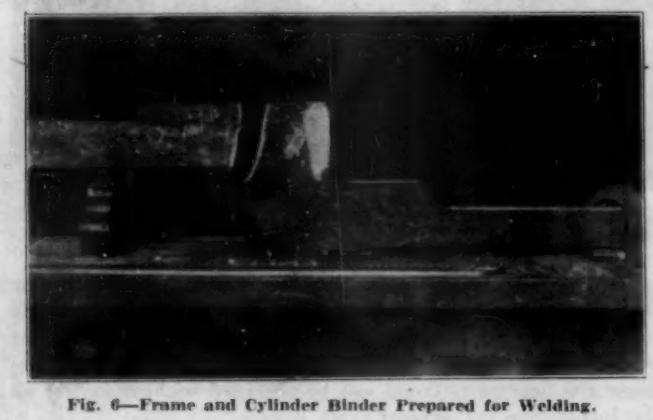


Fig. 6—Frame and Cylinder Binder Prepared for Welding.

are conservative, as they should be in all matters of safety. Engineers and laymen have discussed the pros and cons of boiler welding, while railway officials, by reason of pressing needs, have gone ahead with welding and are doing it daily with few failures. Boiler welds have stood the trying conditions of railway service for years. The practice saves time and labor expense, and in general promotes durability because riveted seams and double sheet thicknesses are eliminated; overheating is avoided and circulation is less impeded.

Frames

Cracked and Broken Frames. Before the advent of modern welding processes the repair of a broken locomotive frame was a heavy and costly job. The frame had to be removed, which meant dropping the driving wheels and stripping of springs, brake rigging, and all parts depending on the frame for support. Frame bolts were removed with difficulty, often requiring drilling to loosen them when rusted. In consequence new bolts had to be forged and fitted.

The frame was heavy and cumbersome to handle in the blacksmith shop. Experience and skill were required to make a sound weld and at the same time avoid changing the length of the welded member. Often the weld necessarily distorted machined surfaces to such degree that planing was necessary. The ordinary labor required to move and replace a frame alone amounted to a considerable item.

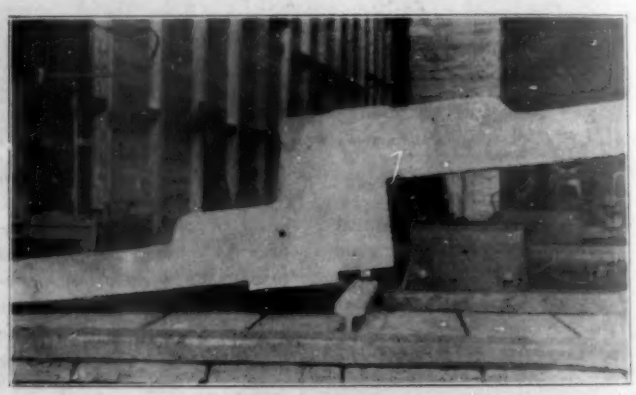


Fig. 7—Frame and Cylinder Binder Welded.

When a broken frame is torch-welded it often can be done with the removal of no parts, or by dropping one pair or drivers and stripping the brake rigging from the frame next to the weld. Weld preparation may take two hours and the weld itself four to six hours, and cooling down, six to ten hours. Twenty-four hours may be sufficient time to start and clean up in. Compare this with the week or ten days not uncommom under the older conditions of railway shop practice.

Preparing Frames for Welding. The welder can save or waste considerable time, gas, and welding rod when preparing a frame for welding. The conventional practice is to vee the frame as shown in plan in Fig. 1, making the angle of the vee about 90 deg. The reason for cutting a vee

when preparing for a weld is simply to give access with the torch to the parts to be unitel. All metal cut away must be restored, and that cut away unnecessarily represents waste of effort and materials, Hence an expert welder working for the common interest of himself and his company will consider carefully the preparation of a heavy-section weld in a locomotive frame. Instead of cutting the vee with straight sides he will be well advised to cut them somewhat along the lines of Fig. 2. The metal represented in areas *A*, *A*, *A*, *A* will be saved and still plenty of space assured for manipulating the torch and making a sound weld.

A still further saving can be made by not cutting the ends to a sharp point, but leaving from ¼ in. to ⅜ in. at the center untouched. The layout will then be approximately as shown in Fig. 3. The areas *A*, *A*, *A*, *A* are thus enlarged. The ends must be jacked apart a distance of ¼ in. to ⅝ in. before starting to weld in order to provide contraction allowance and to preserve the original overall length.

On a frame section 4 in. thick and 5 in. deep, about 20 cu. in. of frame material can be saved as compared with that removed, if the vees are cut as shown in Fig. 1. This means a savings of 1 to 1½ hr., 6 to 7 lb. of welding rod, 120 cu. ft. of acetylene, and 130 cu. ft. of oxygen. The saving effected will be sufficient to take care of the reinforcement or building up of the weld above the original frame surfaces.

Fig. 8—Lower Frame Member Ahead of Front Driving Wheel Jaws, Prepared for Welding.

Fig. 9—Lower Frame Member Shown in Fig. 8 Welded.

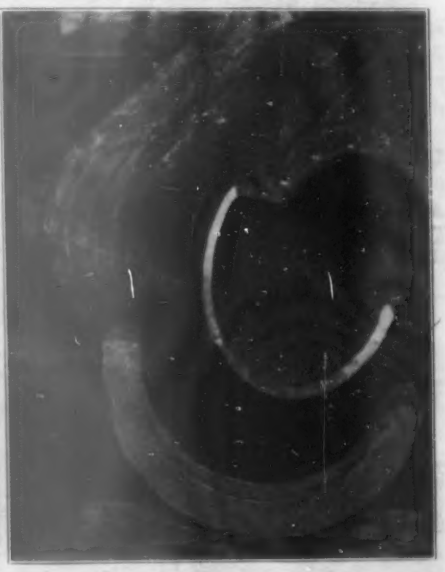


Fig. 10—Cast Iron Cylinder Patch Ready to be Welded in.

Worn Frames. Frames chafed by spring hangers are repaired by building up the worn places to the original thickness. In some shops, pieces are laid and welded at the ends. The objection to this practice is that, as ordinarily done, frame strength is not restored, whereas, if built up by sound welding the worn section is made practically strong as when new.

Cylinders, Piston Rods, Pistons

Cylinders. Repairs to cylinders include welding cracks in the barrel, replacing parts broken out in collisions or by breaking piston rods, broken cylinder heads, replacement of broken bridges in valve seats, etc. In some cases brazing is preferred to welding where a short crack has developed. The repair can be done at less cost and generally with entire satisfaction. Steam passages in the cylinder saddle can be repaired by brazing when the cracks are accessible. Such jobs will generally require the cylinder to be removed from the engine, whereas most repairs to the barrel and valve seats can be done without stripping the cylinder from the engine.

Piston Rods. Piston rods that have worked loose in the piston are built up on the taper so that the taper part can be turned and fitted without losing the original overall length. Sufficient metal should be put on to allow for reaming the piston. In this way a piston rod can be saved at comparatively small cost.

It is not generally advisable to attempt the same treatment for a loose fit in the crosshead. The preferable method in this case will be to fill in the forward end of the key slot with a "dutchman" welded or brazed fast and then to fit the piston rod in the crosshead. If this refitting shortens the rod too much, the taper at the piston end should be built up and refitted, as before described, to compensate for the loss of working length.

Worn Guides. Crosshead guides badly worn on the sides may be restored to standard width by welding thin steel strips to the sides and then planing the guide to width. The steel strips should be not less than ⅛ in. thick when finished by planing. If the amount worn away is insufficient to permit the use of strips of the required thickness, it will be necessary to plane the sides down before welding on the strips.

The strips should be toe-welded, that is, welded along the edges and ends only. Where broad surfaces are built up in this manner to compensate for wear it may be desirable to drill holes in the middle through which the plate can be welded to the part beneath. These welds prevent the plates from buckling and springing away.

Worn Pistons. Pistons worn away on the lower sector are restored to size by building up the worn surfaces with manganese bronze. The bronze is fused to the cast iron and is piled up to the required height to restore the piston to the original diameter. A core plug is removed before preheating the piston to prevent setting up a dangerous pressure in the cored interior should oil and water have worked their way inside.

In laying up the bronze on the piston, the operator should avoid filling in the piston-ring grooves. Of course, that is easily done; the bronze should be built overhanging the grooves so that when the piston is turned and the grooves machined in the lathe there will be enough manganese metal to clean up and make a workmanlike job.

Wheel Centers

Cracked Wheel-Center Hubs. It is not generally considered advisable to attempt the repair of a cracked wheel-center hub. Conditions sometimes have been such during the past few years that it was not feasible to balance the cost of new parts against the cost of repaired parts. In other words, new parts were not available except on long-time deliveries, and

it became imperatively necessary that the old part be restored to working condition; hence we have an example of welding a cracked hub. The cost was high, but high as it was, it was acceptable, because making such repairs meant putting a locomotive into service.

To weld a cracked hub is an undertaking worthy of the skill of the best welder. It can be done successfully at a cost comparing favorably with that of a new steel center, but perhaps greater than the cost of a cast-iron center. This will depend on local conditions, wages, costs of gases, and other items going into the cost of shop repairs.

A wheel center having a cracked hub is welded lying down. Of course the wheel must be pressed off the axle and the crankpin should be removed, as it is likely to be loosened by the heat. The crack is veed out on each side. Observe the same rule specified in the section on welding frames, and avoid as far as possible removing metal unnecessarily.

The wheel center should be blocked up on firebrick or iron supports and preheated with a charcoal fire for several hours before starting to weld. If the rim is solid it must be cut apart opposite the weld in order to provide for the expansion of the center. In fact, it may be necessary to make two opposite cuts through the rim to take care of this expansion. In passing, the author would say that it is not necessary, usually, to weld the cuts made in the rim. Filling pieces may be, and are, fitted in the gap to take the contraction pressure of the tire.

ends spread apart about ⅛ in. before starting to weld. The spread between the ends of course depends on the wheel diameter and the size of the spoke section.

Spreading the spokes apart is generally done by heating the rim and adjacent spokes with an oil burner or other convenient means for local heating. The spoke should be trammed before spreading the ends apart, and the original length carefully prickmarked, the same as in frame welding. In this case, as is the rule in all others, a tram should be used long enough to span the heated area—say, 18 in.

Care must be taken that the allowance for contraction between the spoke ends is maintained until the weld is finished. Generally, the welding is done without removing the wheel from the axle and with the wheel in a vertical position, as this makes it easy to roll the wheel from time to time to favor welding.

An expert welder of experience can handle spoke welding so well that when finished and cold the contour of the rim will be practically perfect. The aim in all cases should be to raise the rim to the original position, or slightly higher. If the rim is slightly raised when the spoke is finished, the shrinkage of the tire on the wheel center will compress the weld metal in the welded spoke, making the shape practically true. It is hardly possible in spoke welding to raise the rim

Fig. 11—Cylinder Patch in Place Ready to be Bricked in for Preheating.

Fig. 12—Cylinder Bricked and Preheated. Welding in Progress.

Fig. 13—The Finished Job, Ready to be Assembled.

Welding the hub can be done so that the axle bore is reduced sufficiently with good management to permit fitting to the old axle, but the crankpin hole will be enlarged by removal of the pin, and it is generally advisable to rebore it to insure truth with the axle. This means of course that a new crankpin will be required.

Two welders should work together on heavy welding in order to insure continuous and rapid work, and the maintenance of favorable conditions throughout the job. This applies especially to frame welds.

Wheel-Center Spokes. Cracked and broken spokes of cast-iron and steel driving centers are welded successfully, if provision is made for expansion and subsequent contraction. This means that the tires must be removed from the wheel centers before undertaking to weld. Attempts to weld spokes with the tires in place are always unsatisfactory. The wheel-center rim will be pulled away from the tire, leaving a space between which, if not filled with a tightly fitted shim, will result in a broken or loosened tire.

The ends of the broken spoke are beveled or veed and the

so much that truing up in a wheel lathe will be necessary, and it would not be advisable to do it if it were possible, because of the increased cost and the liability of being obliged to reduce the diameter below the standard size.

Pipes, Tires, Etc.

Steam and Exhaust Pipes. Broken ears on cast-iron steam and exhaust pipes are restored by welding. Usually no attempt is made to preserve the bolt holes. The ears are built up and the holes drilled.

Surfaces of steam and exhaust pipes that have been wasted away by corrosion are readily built up to their original thickness. In all cast-iron work of this nature the casting must be preheated to a dull red to prevent undue expansion and contraction stresses. Although kerosene burners are much used for preheating, charcoal is also much used where available, and is preferred by many welders because of the soft diffused heat and more agreeable characteristics.

Firebrick, sheet iron, and sheet asbestos are empolyed in building preheating furnaces, suitable for any size or shape. Charcoal quickly takes fire and produces the degree of heat

suitable for preheating work without danger of overheating any spot excessively. Sheet asbestos is used liberally on heavy welded parts while cooling down; also to prevent radiation losses on frames, etc.

Pilot Beam. A hollow steel-casting pilot beam crushed or badly dented by a collision is readily repaired by cutting out the bent section with the cutting torch and welding in a steel plate of the same thickness as the casting wall. The appearance and strength are made as good as new. This repair can generally be made without reheating or removing the beam from the engine.

Sharp Tires. When tire flanges become worn sharp, a dangerous condition exists which must be corrected. Common railway-shop practice is to drop the driving wheel and turn the tires to the correct contour. This means taking the locomotive out of service for several days, and the loss of tire steel that must be removed from the entire set in order that the tires shall be of common diameter and correct flange shape. Often one tire only has developed a sharp flange, and it is apparent that turning the tires is a wasteful and costly practice in the light of present possibilities.

Fig. 14—Bridge Broken Out of Valve Seat.

Fig. 15—Bridge Welded in Valve Seat.

Oxy-acetylene welding is being successfully applied to the correction of this defect produced by uneven wear. If the flange is less than 1½ in. above the tread, the sharp corner is filled in at the base of the flange with weld metal, preserving as nearly as possible the correct contour.

The operation of building up a sharp tire is commonly done at the rate of one tire per man per day, but the time required depends of course on the diameter, extent of wear, and skill of the operator; also on the manner in which the work is handled. If the welder must move the locomotive with a pinchbar to follow around the tire, he loses considerable time, but if the parallel and main rods are taken down and means are provided for turning the wheel by power (referring to the wheel-turning device used for valve setting), welding time will be considerably reduced. The cost of restoring a sharp flange, even under the most disadvantageous conditions, is a fraction of the cost of dropping the wheels and turning the set in the wheel lathe.

Fig. 16—Steel Wheel Center Prepared for Hub Welding.

Brake-Lever Bearing Shafts. A plain shaft 4 in. in diameter and 30 in. long used as the fulcrum shaft for the brake-cylinder levers on a certain type of locomotive is not a profitable reclamation job when badly worn. The cost of building up the worn surfaces and turning to size is more than the cost of the steel and machine work required for a new shaft. It is only when steel of the required diameter and length is not available and the time required to requisition it from the head storekeeper would delay completion of repairs, that reclamation by building up with the torch would be warranted.

Fig. 17—Steel Wheel Hub Welded.

This is mentioned as an example of practice to be avoided by those whose zeal for welding sometimes leads to excess.

Injectors and Air Pumps

Injectors. Injector valve sets worn away by repeating facing with a valve-seat reamer are replaced by boring out the seat and cutting a thread for a seat ring. In time the thread fit between the ring and injector body becomes defective and steam leaking past cuts away the body metal to such an extent that further repairs by old-time methods are no longer feasible. Such jobs are easily made good with the torch, a new wall across the opening being built up with bronze. A small carbon block is set beneath to support the hot fluid metal. This block is removed when the valve seat is bored and faced.

Air-Pump Repairs. The lift of check valves in air pumps becomes excessive when the abutments are worn away by the continuous hammering. These abutments are readily built up with cast iron or bronze to a height that permits them to be faced off to the original standard height, thus making valves of non-standard dimensions to limit the lift unnecessary. This is only one of many minor jobs on air-pump parts that help to keep the motive power in good condition. The master mechanic or other official in charge should study possibilities of cost saving and choose with discretion those that are profitable and reject those that are not.

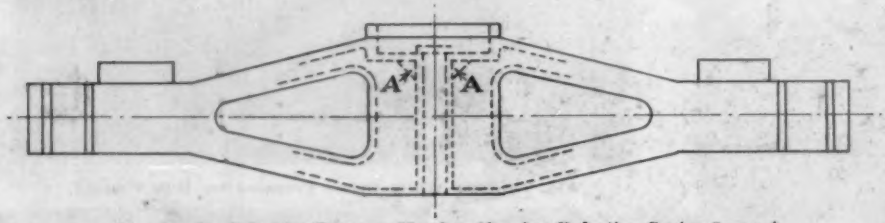


Fig. 18—Steel Tender Transom Member Showing Defective Center Support.

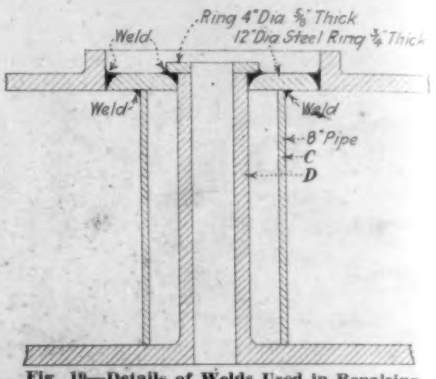


Fig. 19—Details of Welds Used in Repairing Tender Transom.

Steel Tender Transoms

Some tender transoms on certain locomotives proved to be weak in the center beneath the pivot plate. The steel casting broke down, shearing off the ribs, *A*, Fig. 18, that tied the center bearing plate to the kingbolt center. The break was hard to reach with a welding torch. The steel casing was therefore cut away with a cutting torch so that a 12-in. steel-plate disk, *B*, Fig. 19, ¾ in. thick could be set in to make a new bearing. A hole was cut in the center to fit over the kingbolt center *D*, and a piece of 8-in. pipe was cut to fit the distance from the under side of the pivot plate to the bottom member of the transom. The plate *B* and the pipe were welded together, and the assembly set in position. The bearing plate was welded at the edge and center as shown in Fig. 19. To form the inner guide for the pivot casting above a ring about 4 in. in diameter and ⅝ in. thick was cut and welded to the top.

The cost of a new transom was about $40 and the salvage cost about $22. The salvaged transom is about 100 per cent stronger than in the original form.

Supervision

Welding in the railway repair shop, the same as in other special activities, must be supervised by a competent foreman or head welder. In all too many places the welders lead a somewhat happy-go-lucky existence, deciding themselves to a large degree what can be and what cannot be done with the torch. The result is that sometimes hot, disagreeable jobs are "passed up" as being impracticable, and parts are scrapped that could be profitably repaired. Apparatus sometimes is not kept in first-class working order. Pressure gages are allowed to go in disrepair; hose is used in bad condition, and welding tips are thrown away when a slight defect develops that may be easily corrected.

Such conditions are due largely to the fact that many shop foremen having had no personal experience in welding have vague ideas of sound practice. They necessarily depend on their welders to devise ways and means for doing their work, and if the verdict in a particular case is for or against, they feel that they must necessarily accept it. This condition is rapidly improving due, of course, to the awakened interest in welding and also to the valuable service rendered by industrial engineers employed by the large concerns promoting the sale and use of welding equipment and supplies.

Service Rendered by Manufacturers of Gases and Apparatus

The business of a locomotive repair shop is to keep the motive power in operating condition. The energies of those responsible are absorbed in taking care of routine duties and meeting emergencies constantly arising. In general, the officials and their subordinates have little time to spend in analyzing and improving machines or processes, and this is particularly true of the modern welding methods and gas cutting. Service offered and rendered by the large manufacturers of gases and apparatus is a real service that relieves the officials of many worries and helps them to raise the efficiency of their welding and cutting practice.

Railway service comprehends recommendation of torches, tips, gas pressures, methods of welding and welding preparation, analysis of jobs that can be done profitably by welding, training of welders, distribution of gases by pipe lines, installation of pipe lines and safety devices, oxygen manifolds, acetylene generators where desirable, location of welding stations, care of gas cylinders, care of apparatus, repairs to torches, regulators, tips, hose, etc.

Railway mechanical officials have the reputation of being generous in the exchange of ideas and methods. There are few who do not gladly pass on that which they have learned by experience to be good. The railway service rendered in connection with welding and cutting accelerates this exchange of ideas and the adoption of improved practice.

The November meeting of the American Welding Society, Chicago Section, was held Friday, Nov. 2nd, at 8 P. M., in the rooms of the Western Society of Engineers, Chicago. Mr. Herman Ullmer of the Linde Air Products Co. read a paper entitled "Applications of Oxy-Acetylene Welding and Cutting in the Mining Industry." The reading of the paper was followed by a lively discussion which was enjoyed by all present.

Bulletins of the Gas Products Association and the Compressed Gas Manufacturers Association call attention to the need for every manufacturer's cooperation in the effort to improve the statistics of manufacturers compiled by the Bureau of the Census at Washington. An attempt is to be made to advance the date of publication and the figures for each industry will appear shortly after receipt of the reports.

ARC WELDING APPARATUS*

Physical Features of the Arc—Characteristics of Common Types of Apparatus—Various Methods Compared

By J. Caldwell

(*Continued from November issue*)

(7) Direct-current Single Welders

Output.—For general-purpose sets, the maximum loading is 200 amperes at 60 volts. This current is about as large as can be managed in hand operation.

Regulation.—This is the special problem of the single-welder set. The ideal characteristic for such a machine is a flat voltage characteristic from zero up to the full current for which it is adjusted, and a very rapid voltage-drop with any greater current. A general-purpose machine must have some means for varying the current at which this voltage-drop occurs. To prevent sticking, it is necessary to limit the current on striking the arc. It is desirable that current fluctuations caused by the unavoidable variations in arc length shall be checked and limited. The requirements may be summarized as follows:—

(1) A drooping characteristic for any current beyond that fixed by adjustment.

(2) A uniform voltage for currents up to the set or adjuster load, with little or no increase at no load.

(3) Very rapid regulation to counter; the effect of arc variations.

The devices employed with more or less success to meet these requirements can be roughly classified as follows:

(1) Excitation methods. Combinations of self excitation, separate excitation, direct and reversed series excitation. Special arrangements of the magnetic circuit, including pole disposition, proportions and shapes of poles, pole-pieces and yokes, calculated to vary the armature reaction with different load conditions. External regulators acting on the exciting circuits.

(2) Regulation of speed or torque of driving engine or motor by electrical control of governor or transmission clutch.

(3) External regulators controlling resistances in the welding circuit, some times acting simultaneously on one or more of the exciting circuits.

In addition to those automatic regualtions it is always necessary to provide an adjustable resistance to suit the current needed for the particular work in hand. This resistance has to take up 25 to 30 volts with the required current. The ideal set would require only this one adjustment, the automatic devices keeping the output at that level.

Most of the single-welder sets on the market employ one or more of the devices classified above, and some of them are very complex. Such devices as separate exciters and multiple field windings cause a generating set to be larger and much more expensive than a plain generator of the same maximum output.

A sufficient rapidity of regulation to counter arc irregularities is rather difficult to secure. Magnetic flux-changes in fairly massive iron circuits involve time-lag, and inductive action between different windings on the same magnetic circuit has to be allowed for. It is doubtful if the generator can be so altered as to control arc fluctuations. An American designer has recently found it necessary to explain his proposals for a thoroughly automatic single welder by several pages of equations culminating in determinants which reduce into cubic equations and have a forbidding appearance.

Single-welder sets are generally arranged for mounting as self-contained portable machines, with internal combustion engines of the motor-car type, or with driving motor, on trucks or otherwise to suit the users.

(9) Welding-circuit Regulation

Each welder requires a resistance which he can adjust to pass the current required by the work in hand. It is generally stated that this resistance should include some reactance, as the amplitude of current oscillations is thereby reduced. Evidently the reactance should also be adjustable to suit the working current. Reactance probably assists in striking the arc, as it chokes down the current-rush on making contact, and adds a little to the circuit voltage as the contact is broken. Such reactances must have air-gaps, which may be adjustable to suit various currents. One device used to assist the arc striking is an automatic switch which cuts out some resistance as soon as the arc starts.

These resistances have to dissipate from 1 to 6 kW each as long as welding is being done. They are therefore more bulky and expensive for their capacity than starting resistances and the like which are only in use intermittently, and a much more liberal design is necessary. They have to be located within reach of the welders. It is therefore worth while to pay attention to their design in respect to working temperature, ventilation, bulk and protection. The grid form is robust and convenient if made with steel units, otherwise coils are to be preferred. A tapered resistance, i. e., one in which the cross-section is reduced at the successive taps, saves material as compared with a uniform section of resistor. Usually the welding lead terminates in a plug inserted into sockets connected to the taps. Some resistance material could be saved by arranging for sections to be connected in parallel and series combinations, but this would require some form of controller, with doubtful net saving. A finer adjustment than that provided by the taps is sometimes used, and this is advantageous for the finer classes of work. Squeeze-up carbon piles are not suitable for the main resistances, as their resistance changes too much with temperature, and they do not give sufficient range. They are, however, fairly satisfactory for fine adjustment. Evidently, where welding equipments are intended for uniform work, a lesser range of current adjustment is needed than where the work is of a varied character.

(10) Alternating-current Sets

It may be assumed that alternating current will always be taken from a public or works general supply and transformed to the welding voltage. Whilst the current fluctuations on the supply side will be reduced in the transforming ratio, they may still be considerable in the view of the supply undertaking. Welding is a single-phase load with a lagging power factor, and the supply engineer will naturally want to be consulted as to the arrangements. If the supply is three-phase the welding current disturbs the balance of the phases. This can be met to some extent where a number of welders are in use, by dividing them between the phases, or single-phase current can be taken from a three-phase transformer by the well-known method of connecting the secondaries in series with one winding reversed. This equalizes the currents in the primary phases, but in two of them the currents are 60° out of phase, one leading, and the other lagging. It is for the supply undertaking to decide which is the less objectionable, and the user should agree with them at the outset.

Alternating-current welding requires 75 to 90 volts on open circuit. The difference between this and the arc voltage is taken up by means of a reactance in the circuit.

The equipment for a.c. welding is therefore a transformer, to give 75 to 90 volts at the secondary terminals on open circuit and to carry the maximum welding current required for the

There is no sub

WELDING

Welding costs are determined by the performance, not the initial cost, of welding equipment. This fact has been proved again and again by welders who have bought cheap equipment in the belief that it was "just as good." They have found that their belief has cost them the small initial saving on equipment many times over.

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The cost of equipment is small as compared with that of gas and labor. The equipment to buy is that which saves you money on these items.

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work to be done. An adjustable reactance takes the place of the resistance used with direct currents.

The capacity of single-welder sets for a full range of welding is 12 kVA. For multiple-welder sets the transformer capacity may be less, say from 6 to 8 kVA per welder served.

Whether anything is to be gained by using a multiple-welder transformer as against a separate transformer to each welder depends mainly upon the distribution of the welders in the particular case considered. If all the welders are in one shop so that the secondary leads are short, the saving in transformer cost may be worth while. If they are widely distributed over a large factory or shipyard the cost of the long secondary leads may easily outweigh the saving on the transformers. Single-welder transformers may advantageously be designed with an internal reactance which reduces the amount of external reactance that has otherwise to be provided. There may also be a saving in the cost of current effected by the reduction of the total iron losses if single-welder transformers are used. Each case has to be considered on its own conditions.

The open-circuit voltage required for a.c. welding may, in some working conditions, be dangerous. The Home Office has for this reason objected to a.c. welding in some exposed positions. To prevent this danger, apparatus has been devised which reduces the open-circuit voltage to 25 volts and also facilitates the striking of the arc.

A fixed reactance does not produce the dropping characteristic desirable for arc welding in the sharp way necessary; the choke should increase very rapidly if the desired current is exceeded.

(11) Copper, Brass and Bronze Welding

As the result of recent research work, four types of electrodes are now available for the purpose of welding and depositing non-ferrous metals.

The perfection of these products to a commercial stage represents the latest developments in the successful application of electric arc welding for construction and repair.

The metal core is of tinned copper, surrounded by a flux covering, which adheres firmly to the welding rod and does not break away when subjected to transport and workshop usage. This flux covering is of special composition to suit the nature of the copper alloy to be welded, and produces a powerful reducing atmosphere around the work to ensure the deposition of good metal in the weld.

Copper and the various alloys of brass and bronze in general use have a very short temperature-range between the welding and fusion points, and practice is necessary to prevent the metal becoming fluid or remaining in a sluggish condition. Care must be taken to prevent the parts being welded from being pierced by excessive heating.

The heat conductivity of copper is very high, and the deposited metal will lose its heat to the work unless this is preheated to a sufficiently high temperature. Therefore, when using these non-ferrous electrodes it is advisable to preheat the work before starting the welding operation. In the majority of cases local heating along the line of the weld is sufficient, and this may be applied by a blow-lamp. Whenever possible the joint to be welded should rest upon some refractory material, e.g. carbon, asbestos millboard, or furnace lining material.

It is not necessary or advisable to hammer the metal deposited, as this is perfectly homogeneous and free from blowholes.

The electric current requires to be regulated according to the nature and dimensions of the material to be welded. Once this has been ascertained, however, the welding operation should be proceeded with as rapidly as possible, when no difficulty will be experienced in welding copper, brass and bronze with entire satisfaction.

AN ARC WELDED TANK FOR PRIVATE WATER SUPPLY

By Edgar H. Trick

A mechanic who stops to consider the tremendous strides being made in arc welding will soon begin to wonder what will be its effect on the manufacture of punches, dies and riveting machines. The welded joint is replacing the riveted joint so fast that before long the riveter will have to learn to use the arc welder's tools.

The construction of storage tanks is an especially large field for arc welding, and in the construction of these tanks it is well known that the rivet has previously been used.

Arc Welded Water Tank.

The accompanying illustration shows a water tank which was built by the Alamo Iron Works for a private water system for a fashionable residence in the suburbs of San Antonio. The shell was made up of ten steel plates 3/16x80x174 inches, weighing 15 pounds per square foot. The heads were of ½ inch steel, dished outwardly. The weight of the tank was 18,135 pounds. It was 9 ft. in diameter and 35 ft. long. Its capacity was 17,000 gallons. There were 70 ft. of straight seams and 175 ft. of circular seams welded inside and out, which, with the connections made an equivalent of 500 ft. of welding. The openings consisted of a manhole and 1-inch air vent on top and a 4-inch and

Finishing an End Seam.

a 6-inch nipple on the bottom. Not a rivet was used in its make-up. A standard single operator welding set was used and the job required approximately 245 pounds of ⅛-inch and 5/32-inch coated rods. When finished the tank proved satisfactory on a test of 125 pounds per square inch. Very little touching up had to be done after the test, as a few slight sweats at seam joints were all the leaks in evidence. Altogether the job was highly satisfactory and was the source of generous congratulations extended to Mr. Herbert H. Holgreen, the company's welding engineer, under whose direction the job was executed.

EXPANSION AND CONTRACTION

Simple Devices Which Illustrate Expansion and Contraction and How They Very in Different Metals

Paris, France
Saturday.

Dear Ed:

This past week I've just been walking around to save funeral expenses. Today I feel ever so much better so I thought I'd drop you a line while in the mood. Don't know what has been ailing me and it's as good as a Japanese puzzle to find out from one of these French M. D's. The fact remains that I feel greatly improved, so that helps. For that matter, so does France generally. Get me straight on that point. I don't infer that the republic is jubilant over my improvement. No, that's not the case; I mean

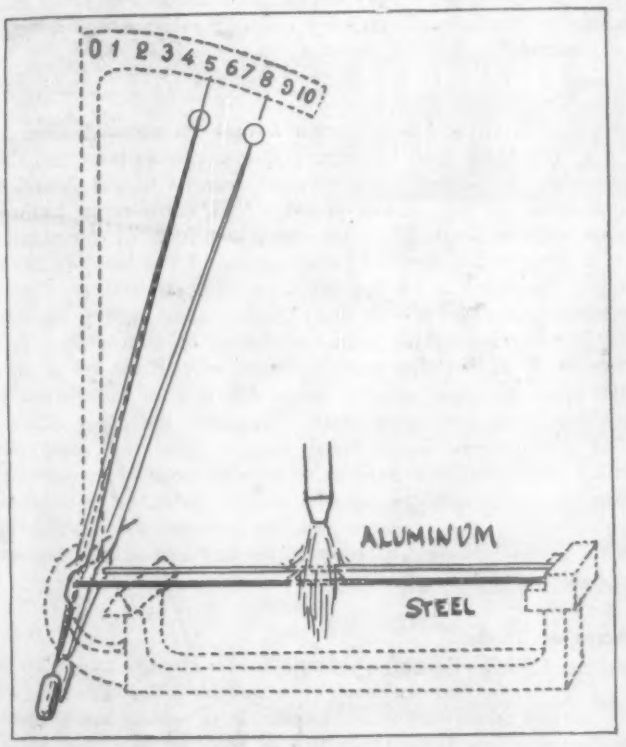

FIG. I

that everybody is treading on air today. They have just cause to; hasn't M. Poincaire, the idol of all France, issued wonderful news? Payments from the Ruhr are to be resumed. Today even the taxis seem to squack louder than ever. Such is life in Paris!

Last week, before I got sick, I had an opportunity to visit some of the biggest welding shops, not only in Paris, but also in some of the neighboring towns. Needless to say, I picked up a pile of good information. They do many things different over here than we do, and the apparatus they use is much different, too. Not only is the ordinary Job-Shop practice different, but they handle their manufacturing different as well. It has been a question in my mind whether to tell you in this letter about these things or to let them wait until next time. The reason I hesitate is on account of hearing a lecture given at the "Office Central." Some parts of it were so good, and to the point that, I have been thinking about them ever since. I might just as well get them off my mind, so here goes.

This particular lecture was one of a series. It was on Expansion and Contraction as related to welding and also dealt with the ductility of metals under the influence of heat. Next to the actual fusion no doubt Expansion and Contraction problems are the welders big problem. A chap called Desgranges gave the talk, which was augumented with lantern slides and testing apparatus for conducting experiments. It was some of this testing apparatus that particularly appealed to me.

The lecture started with a statement that heat produced expansion in metals and cold, a contraction. To prove this fact and obtain further data was the object of the demonstrations. The well known track reference was cited: how the rails expand and come together on hot days whereas in cold winter days they open up. This proved in a measure, that heat causes expansion and the withdrawal, contraction, but a more definite illustration was desired. An illustration where accurate measurements could be taken and comparisons between different metals made. In addition to this it was also felt that it would be desirable to learn whether metals which were expanded always returned to their previous status when cooled.

It was with the foregoing in mind that an apparatus such as shown in Figure No. 1 was built. The body part being designed to receive and test two bars of metal at a time. The two bars must be exactly the same so far as measurements are concerned. The ends of each bar are placed upon and against a solid fitting at one end and the other end rests upon a guide and then comes in contact with lever arms or indicators. These indicators are designed with very long arms and a short pivot in order that any movement, no matter how slight, will be recorded on a dial.

Now to prove conclusively that heat caused metals to expand, the demonstrator placed an aluminum rod in position and heated it. Instantly the indicator showed that the rod was growing longer. A cast iron rod was tried next. The action was the same; it too expanded. Steel and bronze were then tried and they too showed a similar action. Following this came a series of tests showing comparative expansion qualities. Two rods were placed in position and heated at the same time. It was fascinating to see one lever on one side of the dial advance, only to be followed and in some cases outdistanced by the pointer on the opposite side.

Then to conclude this particular experiment, tests were made to determine whether each metal returned to its normal state

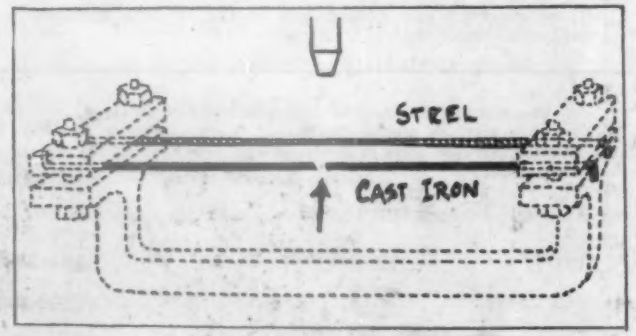

FIG. II

after heating. Various degrees of heat were used until the critical temperatures of each metal was found and then considerable talk ensued, most of which went over my head.

The main point that struck me as I witnessed this demonstration was the simplicity of it all. Here was an apparatus which was not at all difficult to construct and about as efficient as it is possible to conceive. By its use, students could be taught the meaning of Contraction and Expansion in one-half or a quarter the time, and no doubt much more effectively than by the methods now in use.

The second experiment was used also to demonstrate the mean-

(*Continued on page* 32)

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Factory Training Solves Welding Problems

WHEREVER welding departments have been centralized and put under the direction of responsible heads a system of factory apprenticeship for the training of welders within the organization has usually been developed, and with beneficial results. The plant manager who has a definite plan for training his own operators is always a strong booster for welding and is looking for new uses which will enlarge his department. The need for such a plan is more apparent when the welders are brought together into one department and it is much easier to carry it out. Actual training in the theory of the process can be extended over a considerable time after the beginner has reached the point where he can make himself useful, so that in time he is capable of applying his knowledge to a great variety of welding problems instead of being limited to a single operation. Factory apprenticeship has been of considerable benefit to the printing trades. A contrast is furnished in the present building trades situation in the large cities. The cost of good training is small compared to the loss of efficiency caused by haphazard selection of workmen.

The Convention Season

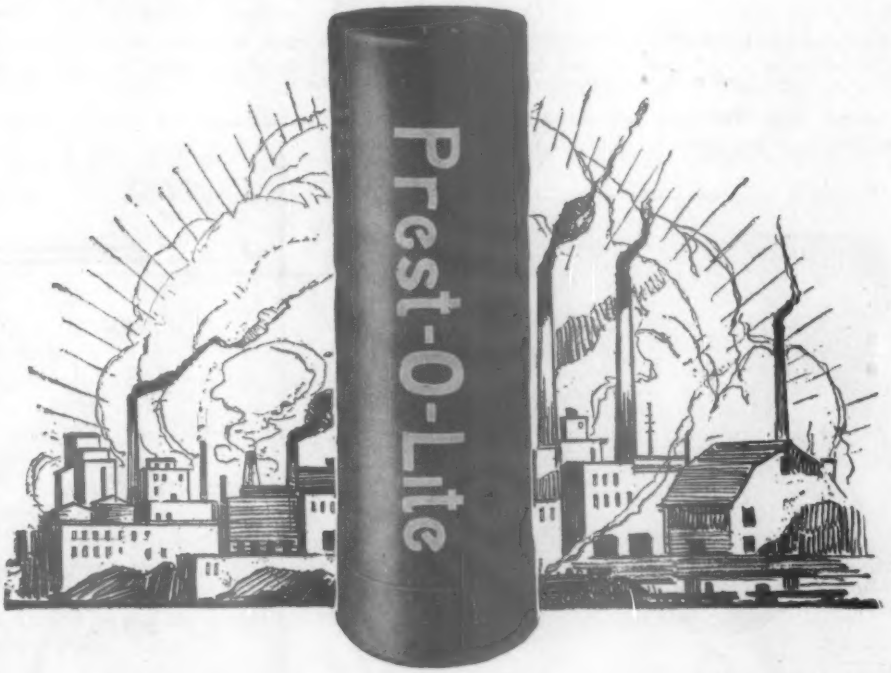
AMERICAN business men have been accused of dividing their time between golf and conventions, yet they seem to have found time between seasons to put American industries on top of the world. And these same business men showed the world some marvelous feats of organization and co-operation four or five years ago. The welding industry is fortunate in having the support of several good associations and every winter finds these groups getting together to compare notes and get an exchange of viewpoints. It is surprising to find how many different ways there are to solve the same problem, what a clever fellow your competitor is, or how your own ideas stack up against the other fellow's, and conventions teach these things. For the most part these benefits accrue only to those who attend the meetings. But the entire industry benefits directly from the information published by the speakers and the committees. If you belong to an association, support it—and attend the conventions. It's worth while.

Acres of Tanks

"ACRES of eighty-thousand barrel storage tanks, as far as the eye can reach" is a traveler's description of the oil storage farms in the southwest. It is safe to say that ten years from now these tanks will be referred to as "antiques" and the all-welded tank will be enjoying its day. Now, if Henry Ford will build more cars, to use more oil, to be stored in more tanks, the developments in tank welding will be encouraged and the all-welded tank will arrive ahead of schedule.

A Test of Welding Skill

LABORATORY and workshop experiments have indicated with fair certainty that for a given job there is a welding rod size, tip size and pressure adjustment which will get the best weld made, at the lowest cost. A foreman who employs a number of new welders every month makes use of this principle in testing new men, by requiring his work to be done with a particular tip and with the gases being delivered at a specified pressure. Those who insist on changing his specifications are immediately taken off the job and subjected to a rigid examination. His experience is that the examination invariably discovers a lack of fundamental knowledge of the process and proves to the welder that he needs more careful training, which is given to him before he is allowed full responsibility for his work. It looks like a good test of skill, because the ability to do the work the right way is bound to be more desirable than the ability to do a passable job some other way.



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TEN YEAR OLD THERMIT RAIL WELDS STILL IN SERVICE

The illustration shows a section of Thermit welded rail which was cut out of the track last year on Carson Street, Pittsburgh, where a stretch of old rail had been welded in 1912, 10 years previous. The condition of the rail surface at the Thermit weld will be observed to be just as good as elsewhere, although the running surface of the rail was much worn down from the effect of many years of traffic. In fact if it were not for the collar of the weld on one side of the rail head, the weld at the rail surface could scarcely be distinguished from the rail itself. A car ride over this Thermit welded section revealed no indication whatsoever of the presence of any joints.

Thermit Rail Weld Stands Long Service Test.

EXPANSION AND CONTRACTION

(*Continued from page* 29)

ing of Contraction and Expansion, with emphasis on the Contraction. You probably noticed that in the first problem most empasis was laid on the Expansion. With this problem the reverse was true so far as emphasis was concerned. The device used in this demonstration, like the first, was very simple. In fact it is nothing more or less than a clamp. The various rods made up of different metal could have their ends clamped rigidly in position and while in this condition heat could be applied to the middle part of the bar. This heating caused the rods to expand, but most of the expansion would take place within the heated zone. They were then allowed to cool and in so doing would occupy less space and contraction strains would then be set up. As you can see from the figure a single bar or a number of bars can be tested at the same time. One of the most interesting experiments using this device occurred when comparing steel and cast iron rods. Everyone knows that steel is ductile whereas cast iron is very brittle. With these two rods in position the heat was applied and as the rods expanded the clamps were screwed down, locking the rods in position. In this form they were allowed to cool. Suddenly the cast iron rod broke and the ends separated about ⅛ of an inch, whereas, the steel rod showed no signs of breaking.

Don't you think that for training purposes the above demonstrations are much more graphic and effective than the old hackened closed "E" casting illustration? To my mind they bring out very forcibly exactly what is meant by Expansion and Contraction. It is all well and good to tell welders and students that the introduction of heat causes metal to expand, but unless they see it with their own eyes they have no conception of how this takes place or how much expansion occurs. Without thi knowledge it is difficult, indeed, for anyone to know how muc provision to make for contraction when executing the ordinar welding problem. This is one item which will vary in th case of every welder, or at least that's the way I look at i By this I mean, if a man is working on a particular part whe

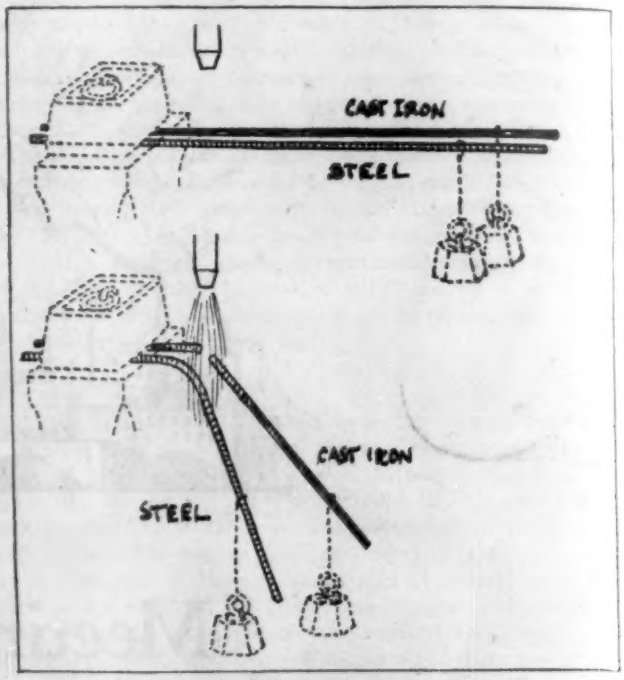


FIG. III

Fig. 3.

the ends must be a certain distance apart, he must know very closely how much to allow for his metal to contract. Some welders cover much more space when executing their welds than others, in fact, I have seen welds just twice as wide as others on the same size job. It stands to reason that the wider the weld the greater the heating zone and consequently the greater expansion. If each welder had some means of testing out the allowance that he should make for his particular work it would certainly be a step in the right direction. That is what I had in mind when I listened to the lecture and saw the demonstration above cited. They would certainly make very valuable assets for any welding school where these points wish to be emphasized.

A third demonstration which proved much simpler than the preceding two was even much more effective in bringing out the ductility of metals. The illustration shows how a bar of cast iron and steel are laid with their ends on the top of an anvil with a weight laid on top to hold them firmly in position. To the projecting ends were attached small weights. The rods were separated about an inch and while in this position heat was applied. As the rods became hot at the zone where the heat was applied, the rods gradually changed color. The steel rod started to bend and then the cast iron rod bent slightly and almost instantly broke off. In the meanwhile the steel rod continued to bend until it almost formed a right angle.

This last problem immediately emphasizes the difference between cast metal and rolled stock. We all know that cast iron is brittle and steel will bend when cold, but under the influence of heat we assume altogether too much when making welds, at least that is the point which the lecturer was trying to bring out. All of these problems are so simple and carry so much weight that I thought you would appreciate them just as much as I did, that's why I am passing them along.

Yours as ever,

Shep.

Hints for the Welder

When you finish an interesting piece of work, can you set down on paper the manner in which you went about the job, how you prepared the work and how the job was done? Have you learned some little stunt every welder ought to know? Contributions to this department are paid for. Write it down any old way – I'll polish it up. Make a rough pencil sketch and our draughtsman will fix it up fine. Line drawings are more practical than photographs. Do it today – the men on the firing line are waiting. L. B. Mackenzie, Editor.

THAWING OUT HYDRANTS

By George Reed

The following is the solution to a problem of some years' standing:

Sometime ago while living in a small town I noticed, and for the second time, a gang of workmen digging around a water hydrant that had become frozen. Such a laborious method caused me to try to find a remedy. After thinking the matter over I went around that way later on in the day only to see these same workmen with a huge hole all around the hydrant and at a depth of five or six feet in order to get below the frost line. They now had a huge oil burner playing all around the lower part of the pipe in an effort to thaw out the ice frozen inside.

The foreman in charge of this work told me that they were kept quite busy with hydrants freezing in this manner, even though they were banked around in order to protect them.

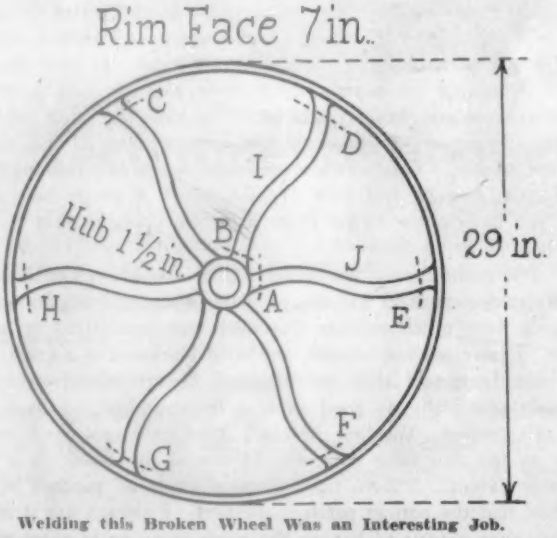
On taking up the above question with the town engineer, I made the following suggestion to him; that the next summer we would have a hole dug around this same hydrant and in the cast iron pipe that connects to the hydrant we would weld a 2-in. cast iron nipple at a depth that would be in the freezing zone. The question of how to tap the pipe with the pressure on was food for thought, but here is how it was done. A circle somewhat smaller than 1¼-in. was drawn on the pipe and all around this circle, spaced so that one hole almost touched the next, were 5/16-in. circles. These were center-punched. We had a small portable electric drill and some small pine wood plugs that would drive nice and tight in a 5/16 hole. We drilled one of the 5/16 holes and naturally a spurt of water shot out but as our drill was protected, it did not harm. We then drove a pine plug in the hole and drilled each adjoining hole and plugged in the same way until all were drilled and plugged. Then we put our 2-in. cast iron nipple which we had made on the hydrant pipe and the circle of holes just came inside the nipple, so we tacked the nipple with the oxy-acetylene torch in four places, then welded all around giving it a full "fillett" as a stronger joint. On the end of this cast iron nipple we fitted a 2-in. brass gate valve which we opened full wide so that we had a clear drive at the piece we had drilled and taking a piece of 1¼ drill steel about 12 in. long, we inserted it in the gate valve, butted it up to the cast iron pipe which we had drilled, and one man held this drill steel near the end with a pair of blacksmiths' tongs while another gave it a sharp blow on the end with a sledge hammer. There was some stream of water shot out of that hole, but after we removed the drill steel we closed the gate valve tight and all was O. K. Where the piece we knocked in went did not concern us much as it could not cause any trouble. The following fittings were added to complete the arrangement. On the gate valve was a short galvanized 2-in. nipple, then a 2-in. brass check valve with brass seat, another nipple and 90° elbow and sufficient of 2-in. gal. pipe to bring the top to a convenient height and close up alongside the hydrant. On top of this pipe was fitted an ordinary 2-in. pipe cap. That concludes the mechanical work.

Our next move was to open the 2-in. gate valve and allow the check valve to take the pressure, then all these pipes and fittings were covered with asbestos pipe covering and treated with hot tar. The idea of the covering was to prevent condensation. The hole was all filled in and next time this hydrant freezes up our portable steam boiler on skids will just connect to the 2-in. galvanized pipe, and 100 lbs. of steam pressure will rush down and eat its way into the very heart of the trouble. On account of the covering no condensation takes place in the pipe and therefore it is not obstructed by being frozen up after the steam is shut off.

REPAIRING A BROKEN FLY WHEEL

By Walter L. Hafley

Over a year ago we were called upon to repair a main drive pulley for a corn shredder which had been broken about as indicated in the diagran. All of the spokes had been knocked out of the rim, and spokes (i) and (j) were loose from the hub. In order to take care of these loose spokes, we welded them to the hub right away and let the welds cool. Then we placed the hub with the assembled spokes inside the rim; matching the spokes to the rim. Next we welded spokes (g) and (h) to the rim and



Welding this Broken Wheel Was an Interesting Job.

let it cool; then applied the preheating flame to the rim between the points (h) and (d), expanding the rim as much as possible while we welded spoke (e) to the rim. We skipped (d) and welded (e) in the same manner, then came back to (d) and over to (h). When the wheel was cold every weld was holding perfectly and the wheel appeared to be in perfect alignment. It has been in use now over a year, and is giving good satisfaction. This wheel was 29 inches in diameter with a 7-inch face. The face was about ¼ inch thick and the hub about 1½ inches thick.

BRAZING CAST IRON CRANK CASES

By Fred Bruckmeier

A short time ago we had to repair a Fordson Tractor crank case which was broken by a loose connecting rod and, although

our previous practice had always been to weld these cases, this one was wanted in such a hurry that we decided to use the bronze filler rod to save time. Our procedure was about as follows: We cleaned off all the grease and then V out all around the break. We also ground back at least ¼ inch on both sides of the break in order to have new metal to work on. Then we welded the small pieces together and placed this assembled piece in the hole and held it there with a clamp. We heated the whole piece with a blow torch to about 200° F. in order to reduce the strain which was set up by the torch when brazing. With the work all covered up, we heated the break about 2 inches at a time to a dull red, then took a piece of cyanide chloride carbonate mixture and used it about the same way as when case hardening small machine parts. Then we took the torch and heated to a dull red again, keeping the bronze ready with a little borax on it. The bronze spread out the same way as on a malleable casting. The whole job required about an hour and was accomplished without any cracking or warping. The finished joint was so smooth that after a coat of paint had been applied, the repaired portion could hardly be seen.

REAR AXLE HOUSING REPAIR

By S. H. W.

About eight months ago a customer brought into the shop a half housing from a Chevrolet. Someone had made the mistake of trying to weld it with steel. The break was located just above the tube rivets on the differential cover and after it had been welded, it, of course, didn't last till they got it back to the shop. We immediately chucked it in the lathe, cut out the old weld and lined it up by using a thin sleeve on the inside. Just as soon as we had it set, we took it to the welding bench and carefully preheated it. We brazed it, using tobin bronze, running this into the cracks below the lathe cut. Then we filled the cut flush. We had forged three plates to fill the contour of the housing. These we brazed in on three sides; where the propellor shaft was bolted on, we did not need to add a plate. After the patch had cooled we put it into the lathe again and turned out the shell which we had used for securing alignment. It came through fine. A couple of months afterwards the car had a broken housing again and was brought in. This time the other half had let go. The portion which we had repaired was O. K., and it had not sprung. This was a commercial man's car, running from California, Arizona and New Mexico, which is pretty hard service. We have never heard from it so we presume that our repair held in good shape.

A few months ago, the writer of an article in *The Welding Engineer*, dealing with the use of patches stated that patches did not help very much because the steel was crystalized before it broke. I have worked around, and with blacksmiths a great deal, and have been told that any fatigued or crystalized steel may be made practically as good as new by annealing. I have also used this method. Welding the crack, then welding a patch underneath on the two sides only, should anneal the frame to a considerable extent. I have tried various kinds of patches myself and find that the bottom patch is the best. I always use it unless the customer objects to having the work show or in cases where the spring shackle interferes too much. If when using a bottom patch both ends of the patch are beveled down, it makes a neater patch and there is far less chance of the frame breaking near the edge if the edges are left secure or welded. Furthermore, many welders use too thick a patch, having a little or no flexibility compared to the rest of the frame, and this results in a break at the junction between the weld and the frame.

LEAKING CRANK CASES

By N. E. Koch

A little stunt which has been quite profitable to me is as follows: We repair leaks in Ford crank cases where the oil comes out from underneath the hanger arm, by taking off the old arm entirely and brazing up the rivet holes or cracks as the case may be. Then we put on an Apco steel repair arm which can be bought at the supply houses very reasonable. These arms bolt on to the cover bolts and do not have to be riveted on.

By being careful we very seldom have to put on even a new gasket on the transmission cover. For a long time I did not think a job of that kind could be done without damaging the coil inside, but we tried one and had good success and have since done quite a number the same way. And the customers were greatly pleased, as it saved them a lot of time and expense in not having to tear the motor out.

O. L. HOWLAND JOINS STAFF OF TRANSPORTATION ENGINEERING CORPORATION

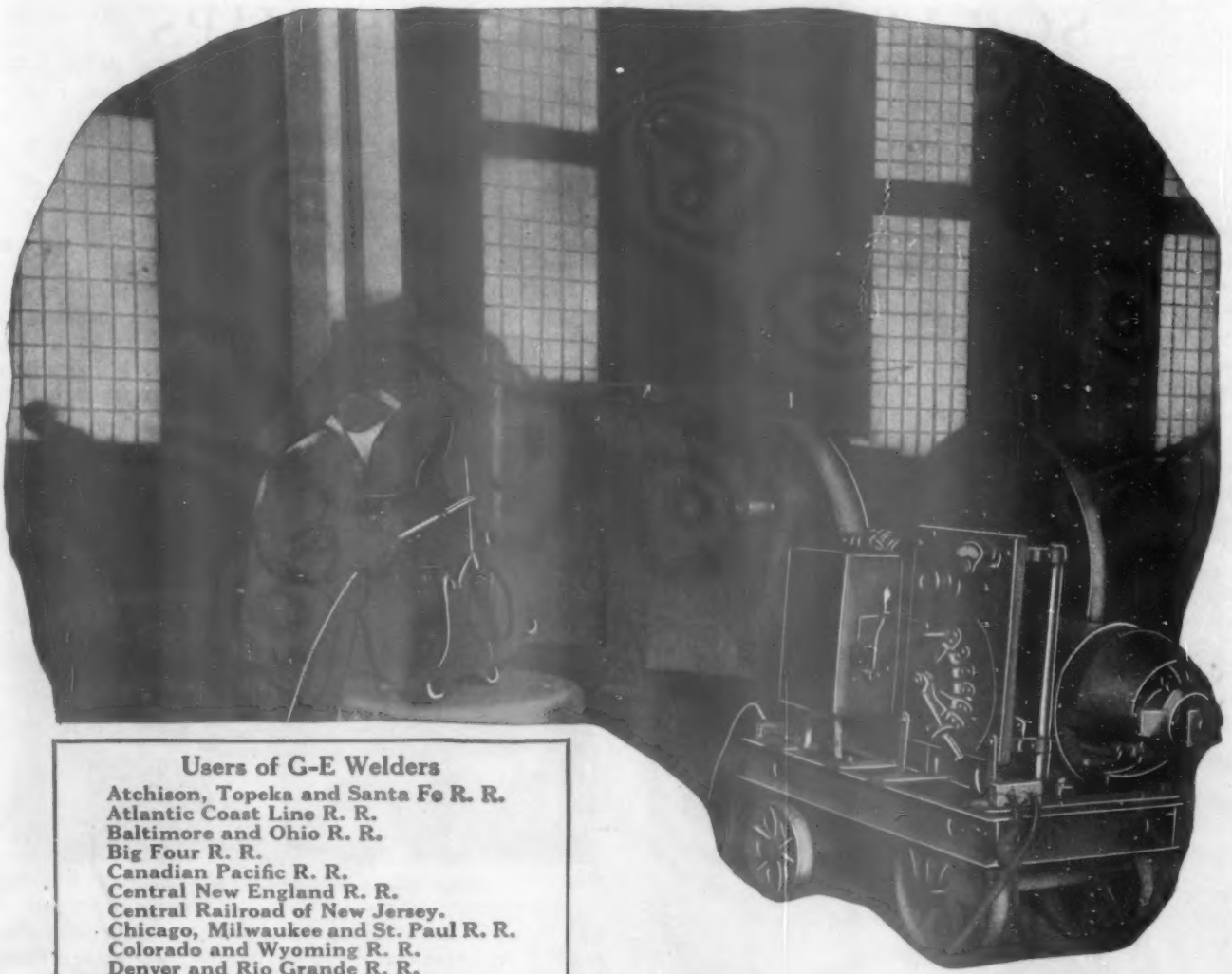
Owen L. Howland has become associated with the Transportation Engineering Corporation, Chicago, Ill., in which position he will be connected with the sale of welding supplies. Mr. Howland was born August 5, 1892, in Kansas City, Mo., and received his grade and high school education at Hillside, Wis. He attended the University of Wisconsin at Madison, specializing in mining engineering. He began his professional career with the Copper Queen Mining Company at Santa Barbara, Mexico, and was later transferred to Bisbee, Arizona. In 1915, Mr. Howland entered the service of the El Paso & Southwestern R. R. Co. at El Paso, Texas, as a boilermaker apprentice, and shortly afterward took up electric welding as applied to the maintenance of railroad equipment. A year later he went with the Baltimore & Ohio R. R. Co. During the next few years, he had a varied experience as an electric welding operator with the Sun Shipbuilding Co., the Bethlehem Shipbuilding Co., the Siemund & Wenzel Co., the Newburg Shipbuilding Co., the New Port News Shipbuilding & Dry Dock Co., the Cambria Steel Co., the Fabricated Steel Tank Co., and the Standard Oil Co. of Wyoming. In March, 1921, he entered the Sales Department of the Central Steel & Wire Co., of Chicago, specializing in the sale of welding wire and rods, where he remained until he accepted his present position.

Owen L. Howland.

WODACK ISSUES LOOSE LEAF CATALOG

"Electric Tool Facts" is the title of a loose-leaf catalog now being issued by the Wodack Electric Tool Corporation, Chicago. It covers a complete line of portable electric drills, grinders, and buffers, which are made for a great variety of industrial purposes. The book is of convenient size and attractively printed, and so arranged that separate sections can be detached and supplied as bulletins covering individual items in the Wodack line.

The board of directors of the International Oxygen Company, Newark, N. J., at their meeting on Nov. 10th declared a dividend of $3.00 per share on all outstanding stock, payable on or about Dec. 15, 1923.



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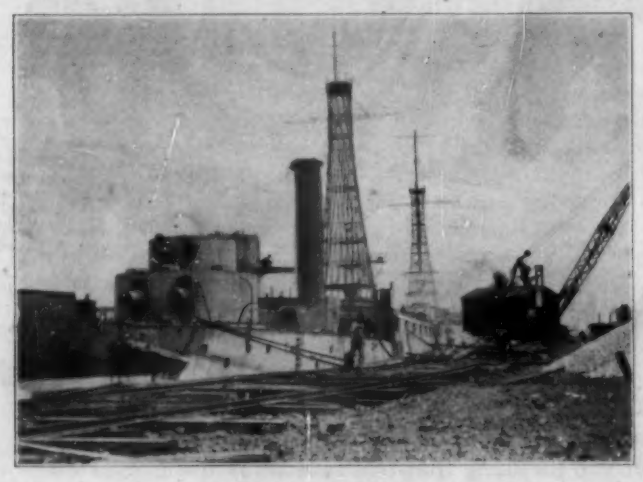
SCRAPPING BATTLESHIPS*

Use of the Oxy-Acetylene Cutting Torch to Accomplish the Complete Demolition of Cruisers in Navy Yards

By G. O. Carter

OVER at the Brooklyn Navy Yard a few days ago Rear Admiral Plunkett, Commandant of the Yard, took an oxy-acetylene blowpipe in his hands and demonstrated to representatives of the press, moving picture camera men and the officials of a large number of salvage and scrap metal concerns, how easily capital ships could be reduced to scrap by oxy-acetylene cutting. This demonstration was preliminary to the government's request for bids for the purchase of the ships to be retired under the provisions of the Armament Limitation Agreement, and through the wide publicity given it, has called the attention of the country to the oxy-acetylene cutting process as a means for accomplishing results which could be brought about in no other way.

The Brooklyn Navy Yards demonstration of the cutting blowpipe is the most recent incident in a long series of developments which began about 15 years ago when the wreck of the battleship Maine was cut up with an oxy-acetylene blowpipe in Havana Harbor. It is likewise another step in the most stupendous ship scrapping program ever under-

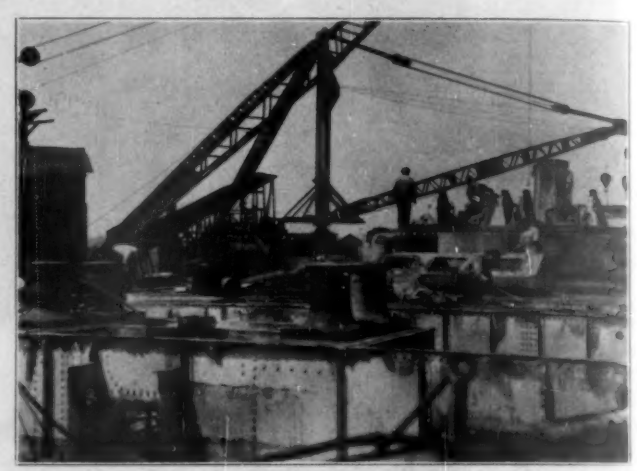


First Stage of Demolition.

taken and it will no doubt focus the attention of a large number of people upon the oxy-acetylene process and upon the work which can be done by its use.

I would like to go back, as a further introduction to the information on the up-to-date practices in ship scrapping, and recall to you the work done in Havana harbor at a time which represents almost ancient history in the oxy-acetylene process. When it was decided to remove the wreck of the old battleship Maine the first thought, of course, was that the plates constituting this ship should be broken down by cutting the rivet heads with an air chisel or with a hand chisel and sledge. Before the job was even attempted, however, it appeared as though the time which would be required to break up the wreck in this way would be out of all proportion to the results to be accomplished and it became evident that more practicable means for doing the work must be had if the work were to be completed within a reasonable time. Oxy-acetylene cutting was offered a trial and after the first demonstration of this process as compared with the old methods the latter were abandoned in favor of oxy-acetylene cutting.

The hulk of the old battleship Maine, at the time this breaking up started, had been exposed to the elements for nearly thirteen years. The parts of it which were under water all or most of the time were badly corroded through the galvanic action of the sea water and were encrusted heavily



Another Stage in Demolition of Battleship.

with barnacles and other marine growth. In places corrosion had been so severe that the ½ in. steel plate was entirely eaten through and in other places seams were so thin that comparatively light blows of a sledge served to sever the joints between the plates. Opposed to this, however, were sections of the ship's armor and other heavy parts which were protected rather than weakened by the action of the sea water and the animal and vegetable life clinging to the wreck. Parts of the ship which had remained above the high water level were in fairly good condition but bore a very heavy coating of rust.

These last two factors were a distinct disadvantage when the use of the oxy-acetylene blowpipe was attempted and would have served to make easier and more rapid the demolition of the structure by the old manual methods. However, oxy-acetylene cutting overcame every obstacle and was the method used to break up the Maine.

From the time this work was completed down to the period immediately after the World War, oxy-acetylene cutting has been used in many cases for reducing steel vessels, no longer required for service, to scrap sizes. While some of the jobs done during this time were spectacular in themselves and presented factors to bring them individually to the notice of the public this application of the oxy-acetylene cutting process did not demand front-page attention in the newspapers again to any extensive degree until the government began to sell obsolete naval vessels of all kinds after the close of the World War.

The scrapping of these vessels, as you gentlemen know, began about 2½ years ago. Bids were asked for the purchase of a number of first line ships, several transports, many destroyers, submarines and vessels of smaller type. These were offered for sale for scrapping, and in the main were purchased in large numbers by organizations in the scrap business, or in allied lines.

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*Paper read before the American Welding Society, Cleveland Section, October 17, 1923.

†Consulting Engineer, Linde Air Products Co.

In practically every case the vessels sold at this time were towed to a point accessible to railway transportation and broken up by oxy-acetylene cutting. In many cases the propelling and other machinery in the vessels was removed and converted to the uses of commerce; and the purchasers of many of these ships found a profitable market for the brass, copper and other metals used in the fittings or "merchandise" of the ships. In some cases, even the wire constituting the communications system within the vessel was salvaged and sold again for commercial purposes. Refrigerating machinery, pumps, cranes, and handling machinery were removed and resold as parts of commercial equipment. In many cases the armor of these boats was removed intact and returned to the government, the obsolete ships first sold having been disposed of under an arrangement which provided for this.

When these vessels were stripped of all their portable or semi-portable equipment the oxy-acetylene blowpipe was utilized in every case to reduce the superstructure, the hull and the heavy fittings to charging box size. There was never the slightest question about the use of the oxy-acetylene cutting blowpipe for this work, all previous experiences having clearly pointed to the fact that by no other means could the vessel be as economically reduced to remelting sizes.

Now, at a time when all but possibly one or two concerns have finished the work on obsolete vessels purchased from the government for scrapping, comes the ratification of the Five Power Naval Armament Limitations Agreement which projects the country into a more extensive ship scrapping program than was ever before undertaken.

Scores of ships, from great battleships, thoroughly equipped and in commission, to new battle cruisers on the ways, designed to be the speediest and most powerful fighting machines afloat, are to be scrapped; and the arrangement under which they are being dispossed of provides that they shall be reduced to such a condition that neither the vessel as a whole or any of its parts shall again be used as equipment for combat purposes.

Cutting the Deck Plating.

Two of the first vessels sold under this agreement, the old battleships Ohio and Kentucky are now in the course of demolition at Philadelphia. When the breaking up of these vessels was undertaken no means of doing the cutting work other than the oxy-acetylene cutting process was considered. Experiences in ship scrapping dating back to the breaking up of the Maine all pointed to the fact that by oxy-acetylene cutting only could this work be done speedily and economically. The Kentucky and the Ohio are now cut down almost to the water's edge, and again the oxy-acetylene process has proved its worth for this work.

These two vessels are being broken up at a point near the Philadelphia Navy Yard. At this place tide water dockage is available and a railway spur makes it possible to handle the scrap metal directly from the ships to freight cars. The direct handling of the cut material reduces the handling costs and in the same ratio increases the gross profit made by the contracting company from their undertaking.

The people doing this work are a very large firm of general contractors and their past experiences in erection and demolition work enabled them to plan many of the factors involved in the scrapping of these two vessels to the best advantage. Heavy travelling cranes are used, these being located at points where they can move material, which has been cut to charging box size, directly from the hulls to the waiting cars. It is also possible to lift such portions of the ship as may be desired almost intact to a point on shore where they can be further reduced to size for shipment.

Cutting 16-Inch Thick Armor Plate.

The Ohio and the Kentucky were ships of the same type and each had a displacement of about 12,000 tons. They were 394 feet long, had a beam of 72 ft. 2½ in. and a draft of 23 ft. 6 in. The armor belt of each was 16 in. thick on the hull and the turret armor was 13 in. thick. The main armament consisted of 12 in. guns, 4 being mounted on each vessel. Together, the boats represented about 24,000 tons of steel and several hundred tons each of brass and copper fittings.

The scrapping of these ships was begun by cutting off and removing the deck fittings and superstructure including the masts, stacks and boat cranes. Most of this equipment was cut on the vessel only sufficiently to remove it, and was further reduced to charging box size after it had been lowered to the mainland. Through handling part of the work in this way the operators were enabled to attack the remainder of the superstructure and the deck plates unhindered by work going on above them.

The large guns were cut into pieces in place and were swung directly from the decks to waiting gondola cars. The cutting of this armament represented quite an interesting oxy-acetylene application and was handled with ease and very speedily with hand cutting blowpipes.

When the decks were cleared of most of the metal which could be conveniently removed, large openings were cut to permit the removal of machinery and fittings from below. Such of this equipment as could not be economically salvaged and sold for commercial purposes was also reduced to scrap. This also applied to much of the piping and other fittings in the hulls of the ships.

About 30 per cent of the weight of the ships of this type is armor and upon the handling of this material depends, to a considerable degree, the profit of the whole scrapping operation. In this case the armor belt and the turret armor was removed from the ship to the shore where it was cut to the charging box sizes before being loaded for shipment.

Several difficulties were met with in the scrapping of the armor. The first of these was occasioned by the composition and the condition of the material itself. This armor is, of course, a special alloy steel, case hardened to a depth of several inches on the outside and was backed by six inches of teak.

The case hardening on the outside surface of the armor made it advisable to cut this material face down; but after the armor was placed in this position no difficulties were encountered in cutting it with either the hand cutting blowpipe or a blowpipe mechanically guided in what is known as a straight line machine. The protective deck and the lighter armor was cut in place and loaded directly from the ships to the cars. In various sections of the boats the plating consisted of several laminations, often made up of different kinds of metals. In many sections these laminations were separated by heavy coatings of red lead or some other type of paint or protective covering which, although at times it rendered the cutting less speedy and less comfortable than it otherwise would have been, did not interfere with the progress of the job.

Armor Cut into Slabs with the Oxy-acetylene Blowpipe.

As I have mentioned, the people who are scrapping these two war vessels are large general contractors. Their experience in oxy-acetylene work has been varied, but up until the time they undertook to break up the Ohio and Kentucky their largest oxy-acetylene demolition job consisted in work similar to the wrecking of the South Street Bridge over the Schuylkill River at Philadelphia. The problems to be met with in cutting down a bridge, however, are very different from those involved in reducing a battleship to scrap metal, and the fact that no serious difficulties were encountered in the latter work is a forceful illustration of the contractor's ability and of the adaptability of the oxy-acetylene cutting process. This also emphasizes the fact that contractors and others who have handled engineering operations should have no difficulty in utilizing the cutting blowpipe for this application, and should not hesitate in undertaking work of this character by oxy-acetylene cutting. Many concerns who contemplate entering bids for vessels to be scrapped under the Armament Limitations Agreement have watched the progress of this work at Philadelphia with great interest and there is no doubt that the lessons they have learned have convinced them that the oxy-acetylene cutting process has made it possible to handle this work at a substantial profit; work which could be economically done by no other method.

Another outstanding case where oxy-acetylene cutting made possible the speedy and profitable demolition of a first line ship was the scrapping of the cruiser "Brooklyn" out on the coast a few months ago. In this particular job practically the same problems were met as in the scrapping of the "Kentucky" and the "Ohio," and as in this later work all were easily overcome by the application of the cutting process.

We in the oxy-acetylene industry can therefore feel assured that the process we are sponsoring is proving a distinct asset to both the industries and to the government of this country through its adaptability to ship scrapping.

The value of the oxy-acetylene process to the industry of the country in this work lies in the fact that, through rendering the metal available for re-use it has made possible greater profits to the demolition contraction and to the producer of steel products.

The process is an asset to the government since with this method for the economical scrapping of steel ships available the government will be able to dispose of their surplus naval equipment by other means than towing the vessels out to sea and sinking them, a matter which would be an expense to the government rather than a source of revenue. Since the steel vessels to be disposed of may be profitably scrapped on a commercial scale the government is able to sell them and at least realize a small part of their initial cost.

AUTOMATICALLY CONTROLLED SPOT WELDING MACHINE MAKES THOUSANDS OF WELDS AN HOUR

A spot welding machine with an automatic control that makes possible a very high speed of operation is manufactured by the American Electric Fusion Corporation of Chicago. Its range of application includes practically all production welding operations from the welding of fine wire to the joining of comparatively heavy sheet steel.

In spot welding, the material to be welded is placed between copper dies, or electrodes, which are brought firmly together by either foot or motive power. Since the copper dies are good conductors of electricity and the metal to be welded is a poor conductor, when a heavy current is passed through the circuit, the metal to be welded becomes heated. When the heat reaches a high enough temperature, pressure is applied and the weld completed.

With the automatic control with which the welder of the American Electric Fusion Corporation is provided, the current is turned on and off, and the pressure applied, by the controlling mechanism. The current is applied to a certain definite spot only and in just the quantity and for the length of time necessary. Because of the intense heat and the rapidity with which it can be generated, thousands of welds an hour can be made on small, light stock.

The welder is driven by a Westinghouse type A. R. S. repulsion-induction type motor operating at a speed of approximately 1100 rpm. Mounted on the motor shaft is a quadruple thread worm, meshed with a worm gear, giving a primary reduction between the motor and the lower drive shaft of the gear housing of 1 to 10, which, with equal gears, drives the welder at the rate of 110 spots a minute. Two other gears of the lathe change type are provided, which allow a minimum speed of 80 spots and a maximum speed of 140 spots a minute. Any other combination of gears to suit the work in hand can be used. By substituting a double or a single thread worm and gear in place of the quadruple, a further reduction can be procured down to 13 spots a minute. If a quick change drive is desired, a quick shift attachment with nine steps can be used, giving a range of welding speeds from 20 to 130 spots a minute.

A foot treadle control is used for starting and stopping the welder. This treadle, which, for convenience, is mounted in front of the machine, is so designed that the operator can obtain one or a series of spots, depending on the kind of work. When the control is fully engaged, continuous operation is obtained.

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Denver—Colorado Compressed Gas Co.

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Wilmington—Burdett Oxygen Co.

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Chicago—Acme Oxygen Co., Burdett Oxygen & Hydrogen Co. and Swift & Company.
Decatur—The William L. Oakes Machinery Co.
Evanston—Burdett Oxygen & Hydrogen Co.
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Peoria—Electrox Co.
Rockford—Acme Oxygen Co. and Burdett Oxygen Co.
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East Chicago—Acme Oxygen Co.
Evansville—Kentucky Oxygen-Hydrogen Co.
Indianapolis—Indiana Oxygen Co.
Logansport — Logansport Oxygen Co.
Mishawaka—C. A. Schrader

IOWA

Bettendorf — Bettendorf Oxygen-Hydrogen Co.

KENTUCKY

Louisville—Kentucky Oxygen-Hydrogen Co.

LOUISIANA

New Orleans—Louisiana Oxygen Co.

MANITOBA

Winnipeg—Auto Lite Gas Co., Ltd.

MICHIGAN

Allegan—A. J. Hodge
Detroit—Burdett Oxygen Co. of Detroit
Grand Rapids — Grand Rapids Welding & Supply Co.
Muskegon—Michigan Ox-Hydric Co.

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Kansas City—Kansas City Oxygen Gas Co. (2 plants)

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Blackwell—Burdett Oxygen Co. of Oklahoma City
Enid—Burdett Oxygen Co. of Oklahoma City
Oklahoma City—Burdett Oxygen Co. of Oklahoma City
Tulsa—Tulsa Oxy-Hydro Co.

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Bristol—Burdett Oxygen Co.
Chattanooga—Burdett Oxygen Co.
Johnson City—Kentucky Oxygen-Hydrogen Co.
Knoxville — Burdett Oxygen Co. and the Kentucky Oxygen-Hydrogen Co.
Memphis—Memphis Oxygen Co.
Nashville—Burdett Oxygen Co. and the Kentucky Oxygen-Hydrogen Co.

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THE IRON WELDING ARC*

Conditions Determining the Transfer of Metal from the Electrode to the Work in Arc Welding

By H. M. Sayers and F. F. M. Sayers

THE object of the investigations described in this Appendix was to obtain some knowledge of the iron welding arc, with a special view to some indications of the conditions determining the transfer of metal from the electrode to the work, and the state of the metal during the transfer. The experiments have been confined to the alternating-current arc at a frequency of 50 periods per second, that being the available supply.

Testing Arrangements.—Optical projection is the obvious way to examine an arc, both visually and photographically, and it permits of some magnification, which is essential with the very short arc that produces a satisfactory deposit.

To get the arc in a fixed position necessary for optical projection and photographing, an apparatus was made which resembles a lighting arc lamp. The electrode is clamped in a holder on a rack which is fed to the work by a series motor through a suitable train of gearing. A brake solenoid connected across the arc checks the feeding speed when the arc voltage is low, and vice versa, so that the arc length is kept approximately constant. There is also a hand-moved regulator in the driving motor circuit, so that the operator has an independent control of the feeding speed, and, consequently, of the arc length. The "work" is represented by a strip of plate clamped to the periphery of a circular table, which is geared to the driving train and revolves at a speed proportional to the electrode feeding speed. The electrode is horizontal, while the "work" strip is vertical and part of a cylinder. A long camera is mounted to one side with some freedom for swinging about a vertical axis passing approximately through the arc, so that the best aspect of the arc can be chosen, and small variations in its position followed by the observer at the screen end. A shutter rotated by a synchronous motor is fitted between the arc and the camera lens, and the stator of the motor is rotatable about its own axis so that the phase at which the arc is imaged can be varied. For photographing purposes there is fitted to the screen end of the camera a plate holder adapted for use with either a stationary or a falling plate. The magnification obtained, is about 4 diameters, and the falling-plate speed such as to give two complete periods (1/25 second) in about 3 inches, so that two periods are obtained on a quarter plate. The arrangement permits of spectroscopic observation of different parts of the image.

It will be seen that the position of the electrode and work is that of "vertical" welding. As only alternating current is available all the work has been done with covered electrodes, some types of which were found to work much better than others. The criterion for this work is that with the mechanical feed the arc shall be maintained steadily for the useful length of an electrode, i.e. about 16 inches. As this is consumed in rather less than a minute there is only just sufficient time to observe or photograph when there are no interruptions of the arc.

For recording the arc voltage and current curves a small oscillograph was made, with a falling-plate camera, which gives also two periods on a quarter plate.

Supply Conditions.—The supply conditions were adjusted by some preliminary trials until the deposit proved good, and were subsequently kept constant. The frequency is 50 periods per second, the open-circuit voltage of the welding transformer about 68, the steadying impedance is partly a choking coil and partly a resistance, the electrodes are No. 14 S.W.G. closely wound with asbestos yarn coated with a flux compound, kindly supplied by Messers Alloy Welding Processes, Ltd., and the current is approximately 30 amperes.

General Appearances.—Observing the magnified image on the screen with the shutter stationary, one sees that the surface of the work is hollowed and rippled, the ripples being roughly concentric and moving outwards towards the rim of the crater. The crater surface appears to be of clean, molten metal. Surrounding it there is a red-hot rim of matter in ebullition, presumably molten slag. At the end of the electrode the covering melts with a steady rotation at the rate of four or five revolutions per second. At each rotation one turn of the asbestos yarn is removed. The molten covering forms drops at the lower edge of the electrode, parts of which fly across to the work at frequent intervals. The path appears to be outside the vapor body.

The arc or vapour mass is of no very definite or constant form, and rapidly changes shape. At the electrode end it appears to be of rather larger diameter than the electrode, and apparently an overlap of it rotates and removes the covering, as described above. It narrows at the work end and seems to terminate on a very bright part of the crater on the work, a patch smaller than the electrode diameter, and of irregular and changing shape. Between the two the arc expands a good deal on the upper side, but not so much on the lower side. It gives the impression that, but for the effect of gravity, it would take a spherical shape, but with a somewhat large segment cut off by the electrode boundary. The color of this arc is a blue violet, and there is no appearance of any drops or particles traversing it. To the eye it is not brighter than the electrode and work surfaces, but the color of the latter is bright red to orange, or nearly white, while that of the arc is blue, as stated. Photographed without any color screen, the arc is far brighter than anything else excepting the bright patch where it seems to terminate on the work crater. It has not been possible to see the actual electrode end, as the flux covering masks it, suggesting that the metal surface is decidedly within the edge of the covering.

Photographed on a dropping plate (with the shutter open and stationary) the arc shows as two bright patches per period. The width of these patches corresponds to about two-thirds of an alternation; and they are brightest in the center, shading off to a sharp edge. The image of the bright spot on the work crater is nearly continuous but is not so bright.

Observed visually with the synchronous shutter and a certain position of the stator, the appearance is not materially different from that obtaining with no shutter. On rotating the stator, i. e., altering the phase of the shutter opening, the blue vapor mass fades and finally, for a space centered on a 90° angle from the maximum arc size and brightness, the vapor mass disappears. The electrode end and the work crater surface are seen glowing, and the surrounding slag boiling, the inference being that the arc is extinguished, or the blue vapor zero-current points.

Oscillograms.—Oscillograms have been made, using the mass non-existent, for a definite interval on either side of the falling-plate method. The open-circuit voltage is approximately sinusoidal. The voltage curve with the arc established has much steeper sides and a broad two-peaked maximum. The arc current curve is a triangular peak with a base of about two-thirds the duration of each alternation. The other third is at zero value. This duration corresponds to the falling-plate photograph of the arc, and appears to mean that the

Prepared for The Institution of Electrical Engineers as a supplement to Major Caldwell's paper on the subject of "Arc Welding Apparatus."

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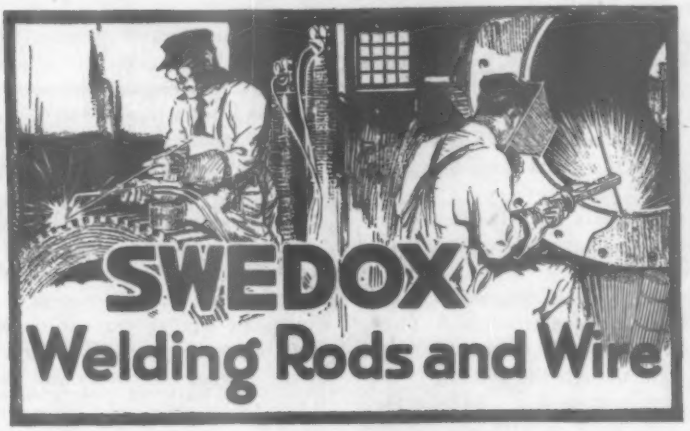

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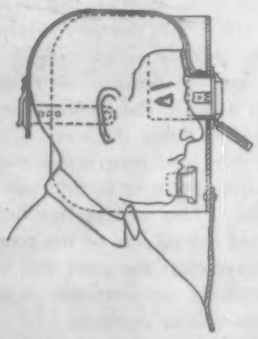

The hinged door allows quick removal or change of the colored glasses without the use of tools. Back of this door is an inner glass which protects the eyes when the operator opens the door to inspect his work. Notice the rigid adjustment illustrated at the left. This keeps the glass always in line with the eyes and the parts being welded, regardless of the position of the work.

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current passes only while the vapor body is in existence. Presumably the current is interrupted and the arc stops at some point in the descent of the voltage, and both are re-established on the following reverse rise of the voltage. It is clear that the arc duration in each alternation corresponds to that of the peak of the voltage curve, the valley between the two peaks of the voltage maximum to the rapid rise of the current, and the rise to the second peak to the rapid fall of the current.

At the time of preparing this Appendix no calibrated measurements have been made of these oscillograms, but it is hoped to make some in subsequent work.

Spectroscopic Appearances.—Only visual observations have been made with a small direct-vision spectroscope. These show a bright-line spectrum of the arc body, which seems to be chiefly the arc spectrum of iron, though the sodium D line is strong, doubtless from the flux composition. Satisfactory observations of the electrode and work spectra during the periods of arc extinction have not yet been achieved. It is hoped to improve the apparatus sufficiently to succeed in these, and perhaps to obtain spectrographs photographically.

Temperature Distribution.—With an image of the arc in a nearly stationary position on a screen it seems possible to investigate the temperature distribution by a thermopile of other means of measuring radiation. This has not, however, yet been attempted.

Method of Transfer of Metal.—The observations made do not justify any decisive statement as to the way in which the iron is transferred from the electrode to the work. They seem, however, to indicate that the arc body is chiefly iron vapor at a temperature considerably above the melting point of the metal. It is possible that this vapor body sheathes and masks a stream of very fine droplets of molten iron, but so far nothing of the kind has been observed. The molten flux-covering does visibly pass from the electrode to the work in fairly large drops, but, as above stated, outside the arc, and below it in this case of vertical welding. The current oscillograms are symmetrical above and below the zero line, i. e., they indicate no difference due to the reversing polarity of the electrode and the work.

It would obviously be easier to observe any such difference as shown by the arc image with direct current, and it is recognized that the investigations described are incomplete without working on direct-current welding arcs.

Quantity of Deposit.—One of the measurements which it is hoped to make with the help of the apparatus described is the quantity of iron deposited per unit of current and time, or per unit of energy in the arc. This again should be observed with both alternating and direct currents, and with varying electrode sizes and currents.

The literature of the subject contains a number of statements on this point, but they vary so widely that one can only suppose that they are made under widely varying conditions and are not comparable. Mr. Langdon Davies has kindly furnished some results of tests made by him. With a No. 8 electrode and direct current he found a deposit of 157.8 grammes per kilowatt-hour, the energy being measured at the input side of a motor-generator. With alternating current he obtained with the same size of electrode a deposit of 315.5 grammes per kilowatt-hour, when the open-circuit voltage of the transformer was 55; and 351.0 grammes per kilowatt-hour when the open-circuit voltage was 45. The energy measurements in this case also were made on the input side of the transformer. As the energy includes the converting and transforming losses it is obvious that the deposit per unit of arc energy must be higher. The greater weight per kilowatt-hour with alternating current is naturally due to the fact that the motor-generator losses were much higher than the transformer losses. The improvement in depositing efficiency due to reducing the open-circuit voltage from 55 to 45 of course means smaller impedance losses between the transformer and the arc. These figures appear to suggest that the deposit per kilowatt-hour of arc energy is of the order of 800 grammes. Measurements with a considerable number of current values and electrode sizes will be necessary to establish the figure, which is hardly likely to be a physical constant in any sense. If it is the case that the iron is transferred as vapor, then there is a limit fixed by the vaporization heat of iron. Having found no record of a determination of this quantity, the authors cannot say what such limit is. Evidently, however, not all the iron volatilized at the electrode is deposited on the work, and the losses by oxidation, condensation, etc., are likely to vary to a large extent with the working conditions. Thus the oxidation losses should be higher with small electrodes than with large, supposing similar current densities, as the ratio of the surface to the mass of the vapor or arc body is greater in the case of the smaller electrodes and currents.

It may be observed that one instrumental difficulty in measuring the arc energy is that there are no integrating meters on the market for voltages in the neighborhood of 20 volts, and an integrating meter (or the integration of voltage and current oscillograms) is the only practicable way of measuring the rapidly fluctuating energy in a welding arc.

Conclusion.—The authors cannot claim to have given definite answers to the question: What are the physical conditions of the iron welding arc? They have, it is hoped, shown ways by which some partial solution may be reached, and if circumstances permit, they hope to pursue the inquiry with improved means and thus to obtain some results of practical utility, and possibly of scientific value.

The work described has been done with home-made appliances, and under the limitations of a dwelling house. With laboratory conveniences and resources, more definite results might have been obtained with less expenditure of time and labor.

STANDARDIZATION OF COST FINDING METHODS

Illustrating the Value of Standardization of Practice in Applying the Welding or Cutting Process

IN many job welding shops, and in some other organizations where much welding is being done, the keeping of accurate cost records has reached a high degree of development. Exact figures are recorded of the time required for preparing parts for welding, preheating, if this is necessary, welding, and any annealing or finishing found to be advisable. In addition to this, provision is made for recording the quantities of gases, welding rod and other supplies used. To the total cost of these factors is added a percentage amount to cover overhead and general expense, and the price to the customer is then set by the addition of a reasonable known net profit.

In some other shops, however, and this classification includes some of the largest welding shops in the country, the matter of cost accounting has not reached this degree of standardization, and prices to the customer are based in many instances upon the price of a new or replacement part, or on a roughly estimated cost of a job, rather than (as good business practice requires) upon a cost actually based upon a definite time, material and overhead figures. It seems reasonable to suppose that in some cases of this kind welding shops are doing themselves injustice by their failure to secure sufficient revenue for the work they do, and that in other cases customers are possibly overcharged, this resulting in the loss of good will by the welding process as a whole, as well as the welding shop doing the work.

The illustrations shown indicate how one progressive welding shop has solved the cost problem, and how cost finding has been standardized in their particular case. This system has been in operation for a considerable time, and the success of the company using it, based to some extent at least upon the good will which has been built up among their customers, indicates that it might be advisable for other shops to adopt similar methods.

The basis of this system consists of three cards, two of which

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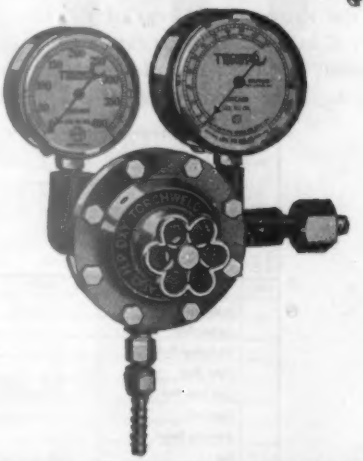

TORCHWELD WELDING TORCHES have incorporated in their design certain exclusive features which make them superior in:

Ease of Operation because they are so well balanced in their construction that they do not tire the operator.

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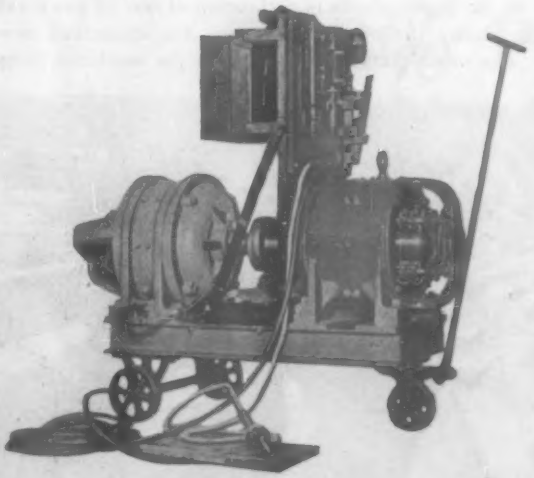

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are illustrated. The third card is the operator's daily record of work accomplished, and simply lists the various jobs on which the individual welder works during the day, together with a record of the time spent on each job.

When a welding job is received in the shop, part of the office record card (Fig. 1) is filled out. This card bears the job number, the name and address of the customer, the date the job is received in the shop, the date the finished work is promised the customer, and the name of the shop employe or official accepting the job. Any special instructions or suggestions given by the

JOB NO.

Job Welding Cost Sheet
Customer's Name
City
Date when Job received
Date when Job promised
Date when Job finished
Job taken by
Job settled by

LBS.	MATERIAL	@	TOTAL	@	TOTAL
	Brass Rod				
	Copper Rod				
	Aluminum Rod				
	Steel Rod				
	Cast Iron Rod				
	Charcoal				
	Asbestos Paper				
	Gas				
	Gasoline				
	Feet Oxygen				
	Feet Acetylene				
	Hours Time				
	Overhead				
Total Cost				Charge	
Total Selling					
Total Profit					

Remarks on back of this Sheet

Office Record Card.

customer are noted on the reverse side. This card is then used as a guide in making the preliminary entries on the shop record card which travels through the shop with the job, after which this office record card is filed in the office until the welding is completed and the finished work is ready for the customer.

The shop record card (Fig. 2) is numbered to correspond with the office record of the job, and shows the date for which the finished work has been promised to the customer. This card does not bear the customer's name, the work being identified in the shop by number only. As the work progresses step by step, the operator records the amount of welding rod used, the number of

JOB NO.

JOB WELDING CARD

COPPER ROD Dia.	COPPER ROD Lbs.	BRASS ROD Dia.	BRASS ROD Lbs.	ALUMINUM ROD Dia.	ALUMINUM ROD Lbs.	BRIGHT STEEL ROD Dia.	BRIGHT STEEL ROD Lbs.	CAST IRON ROD Dia.	CAST IRON ROD Lbs.	FEET OXEY	FEET OXEY		ELAPSED TIME	CLOCK RECORD
												Start		
												Stop		
												Start		
												Stop		
												Start		
												Stop		
												Start		
												Stop		
												Start		
												Stop		

Lbs. Charcoal for Pre-Heating or Annealing	Lbs. of Asbestos Paper	Gas or Gasoline

ANY OTHER MATERIAL USED MARK ON BACK OF CARD

Remarks

Workman's Signature

Date Promised

Shop Record Card.

cubic feet of oxygen and acetylene consumed and the quantities of charcoal and other supplies used in preheating, annealing and finishing. A time-clock record of the work done is kept on this card by the operator, who punches the card whenever he starts and finishes working on the job. While the welding is going on the operator follows the customer's special instructions which are transcribed on the back of the job card from the office record card.

When the work is completed, the job card bears a complete record of the time and supplies used. These figures are posted on the office card in the office, and the cost of the work determined. This cost includes the overhead factor, this factor having been reduced to a percentage of the value of the time and material used. The net profit is based on a percentage of the costs, the total of these preceding items thus determining the fair selling price to the customer.

Of course, this cost system can easily be modified or altered to meet specific needs or conditions met in other shops. In every case, however, standardization along cost finding and price fixing lines has been of a distinct benefit to the shop operating the system.—*Oxy-Acetylene Tips.*

NEW USE FOR HYDROGEN

The new University of California Memorial Stadium has just been finished and was opened November 24th with the annual game between the University of California and Stanford University, resulting in a victory for California with a score of 9 to 0. As shown by the pitcures, the stadium itself

Equipment Used for Marking Seats.

is concrete with wooden seats. These seats are numbered by the Hotgrave process which is the invention of Mr. Geer, of the well known welding firm of Curtis & Geer, of Oakland, Calif.

One of the photographs is a close-up of one of the machines and also shows the numbers as they are impressed into the wood. The other picture shows two of the machines in opera-

Marking the Seats in the New California Stadium.

tion and gives a sort of bird's-eye view of a section of the stadium showing how the numbers have been applied.

Metal numbers get torn off and mutilated, but the Hotgrave process burns the number into the seat. A number made of metal is placed in a small enclosed place in the Hot-

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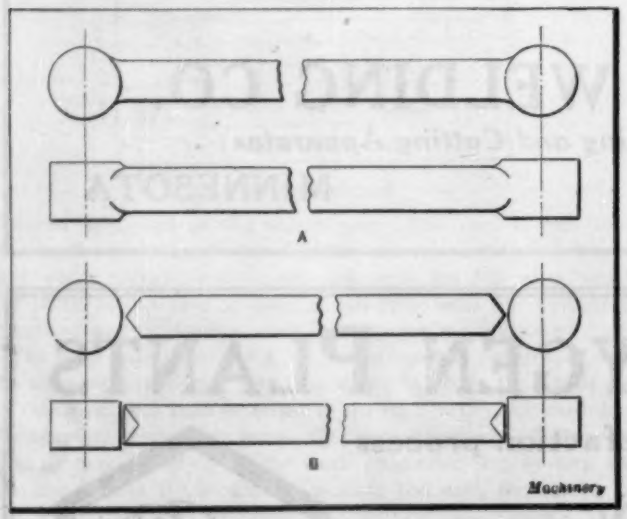
grave machine and the heat is furnished by a small hydrogen-air torch. The metal number is kept at a constant temperature and is applied to the wood by simply pressing it down. Patent has been applied for on the machine. Inasmuch as college stadiums furnish a popular method of spending a lot of money at the present time, this method of numbering seats may be interesting to readers of The Welding Engineer.

REDUCING COST OF CONNECTING-RODS BY WELDING

By Paul J. Rees

Carefully worked out manufacturing methods are necessary when wrought-iron connecting rods of various sizes are to be made in small lots, if the work is to be done neatly and economically. The concern with which the writer is connected requires a variety of rods of the type shown at *A* in the accompanying illustration. However, only a few rods of any particular size are required at a time. These rods vary from 1 to 3 inches in diameter and from 2 to 6 feet in length. The flat ends of the rods also vary in thickness. The thickness of the ends is the same as the diameter of the rod in some cases, and in others it may be as much as 2 inches greater.



Method of Welding Connecting Rods.

The cost of dies for forging the stub ends for small quantities of rods on a forging machine was prohibitive, so the ends were hand-forged and then welded to the rod proper. This method was followed for a long time, but it was, of course, rather expensive. It was found that a cheaper as well as neater looking rod could be produced from three sawed off lengths of round bar iron, welded together.

The two end pieces are sawed off to the exact thickness required and the flat sides clamped against a straightedge, with the connecting-rod properly located between them while welding, so that the ends are in proper alignment with the rod. This eliminates the necessity for facing the bosses, which had to be done in the case of the hand-forged rods. The ends of the connecting piece are pointed, as shown in the view at *B*, with the cutting torch or chipping hammer, in order to facilitate the welding operation.

The weld should be well filleted for strength, and when finished should be buffed smooth. This method of welding on the rod ends, either electrically or with a torch, produces a strong rod and a neat looking job that requires no machining other than the drilling of the ends for the pins. Rods thus made have proved satisfactory in every way, and a considerable saving is effected by this method.—*Machinery.*

News of the Welding Trade

E. F. Platt, of the Portland Oxygen Co., Portland, Ore., has just completed a round trip to New York City. Mrs. Platt accompanied him on the trip According to Mr. Platt, the prospects for business on the Pacific coast next year are very encouraging.

The following officers for the ensuing year were elected at the recent meeting of the International Acetylene Association in Chicago President, E. L. Davis, Acetylene Stove Manufacturing Co., Cleveland, Ohio; vice-president, W. S. Noyes, Imperial Brass Manufacturing Co., Chicago; secretary, A. Cressey Morrison. In the place of R. Sossong and E. S. Mills, retiring directors, D. C. Duncan, Carbic Manufacturing Co., Duluth, Minn. and A. S. Kinsey, Air Reduction Sales Company, New York, were elected.

At the December meeting of the American Welding Society, Chicago Section, held December 7, E. S. Hurd presented a paper on the electric welding of sheet steel, and H. W. L. Porth presented a paper on oxy-acetylene welding and cutting in connection with car repairs.

H. G. Amling, Chicago, agent for Heylandt oxygen and nitrogen producing plants, reports the recent installation of a nitrogen producing plant at Niagara Falls, N. Y.

E. R. Thomas, of the Ohio Oxygen Company, Niles, Ohio, was a recent visitor in Chicago. He says that business promises to keep up with production for some time.

J. M. Jardine, proprietor of the Western Welding and Equipment Co., 1011 W. Lake St., Chicago, has purchased his partners' interest in the firm and is now sole owner of the business.

E. A. Faulhaber, of the Burdett Company, Chicago, is taking his annual vacation between golf seasons, and expects to be on hand again when the winter golf season is well under way.

The trade name of "Canadian" carbide, made by the Shawinigan Products Corporation, has been changed to "Shawinigan." The product will continue to be packed in the well-known green drum.

M. M. Smith, of the Commercial Acetylene Supply Company, New York, was a visitor in Chicago this month.

The Park Way Welding Co., of Pittsburgh, is reported to be making a considerable addition to its present equipment.

The tenth semi-annual meeting of the Gas Products Association will be held in Chicago January 17 to 19, as previously reported. An interesting program of papers and discussions and a pleasant banquet meeting are promised.

B. K. Smith, president of the Big Three Welding and Equipment Co., Ft. Worth, Texas, has been on an extended trip through the north this month. "Ben" says he raises the best grapefruit in America in his spare time.

A branch plant is to be established in Tulsa, Okla., by the Brown Welding & Machine Co., Breckenridge, Texas, under the direction of Cleveland Johnson.

Plans for a new one-story plant on Public street have been filed by the Connely Electric Welding Co. 307 South Water street, Providence, R I.

The eleventh annual meeting and dinner of the Compressed Gas Manufacturers' Association will be held at the Hotel Astor, New York, on Monday, Jan. 21. Special arrangements have been made for special cars to accommodate members and guests in attendance at the meeting of the Gas Products Association in Chicago during the previous week.

The new $200,000 plant of the Louisiana Oxygen Co., at Washington Ave. and Rendon St., New Orleans, is nearly complete and it is expected that it will shortly be in production.

New welding apparatus and other equipment is being installed in the plant of the Advance Welding Co., Coraopolis, Pa.

H. L. Unland, for thirteen years engineer with the General Electric Co., Schenectady, N. Y., most of which were spent in the power and mining department, has become electrical engineer for the Victor Talking Machine Co. Camden, N. J. Mr. Unland has contributed many valuable papers to the literature on electric arc welding.

Mr. Clarence E. Cooper, Insurance, 80 Maiden Lane, New York, was recently elected an associate member of the Gas Products Association.

An apparatus group has been formed in the Gas Products Association to carry on activities which will be mutually beneficial to apparatus manufacturers. W. A. Slack, of the Torchweld Company, Chicago, is chairman of the group.

The office of the Acetylene Journal Publishing Company has been moved from the Peoples Gas Building, Chicago, to the Monadnock Building, 330 S. Dearborn St.

R. E. Kinkead, who has been connected with the Chicago office of the Lincoln Electric Company, recently joined the home office of the company at Cleveland, Ohio.

CURRENT WELDING LITERATURE

LARGE GAS HOLDER FABRICATED BY OXY-ACETYLENE WELDING, by G. O. Carter—Description of the procedure followed in erecting two one-thousand barrel all welded oil storage tanks for an oil pipe line company, with especial reference to methods of handling materials and taking care of expansion and contraction. Illustrations show details of devices used to facilitate the making of the joints—Acetylene Journal, December.

PIPE LINE WELDING, by N. E. Wagner—A review of the progress made in this field in 1923. Details of a method of construction for two section, 90 degree, reinforced welded ells. Use of second hand pipe to construct welded pipe buildings. Development of flange tank nipple. River crossing projects.—Acetylene Journal, December.

WELDING AND CUTTING IN CONNECTION WITH CAR REPAIRS, by H. W. L. Porth—Limitations imposed by Welding Committee of A. R. A. Necessity for Welding. Conditions under which welding must be performed. Characteristics that must be obtained. Caliber of workmen. Examples of work done. Cutting applications.—Acetylene Journal, December.

WELDING STELLITE WITH THE OXY-ACETYLENE TORCH, by Herman Ullmer—Use of reducing flame. Necessity for preheating. Types of welds. The welding operation.—Acetylene Journal, December.

WELDING AND INSURANCE, by A. D. Disteen—A review of the insurance man's point of view with respect to the safety of welded joints.—Journal of the A. W. S., November.

HUGE COAL DRYER OXY-ACETYLENE WELDED, by T. C. Fetherston—Description of the construction of a coal dryer for a large Pennsylvania plant. Materials used, preparation of joints, and welding procedure.—Journal of the A. W. S., November.

ARC WELDING OF FUEL OIL TANKS, by P. P. Pipes—Construction of four large fuel oil tanks in the Equitable Building, New York.—Journal of the A. W. S., November.

RECLAMATION ON SOUTHERN PACIFIC, by E. J. Becker—Savings effected by welding materials which had been discarded as scrap.—Journal of the A. W. S., November.

FAILURES IN ALUMINUM WELDING, by D. Richardson—An investigation of the causes of corrosion in aluminum welds. How various grades of aluminum differ, even when they have the same mechanical properties and physical characteristics. Presence of blowholes revealed by melting. An aluminum-copper alloy is recommended for filler material. Further success depends upon the quality of the plates.—Acetylene and Welding Journal, London, November.

(Continued on page 48)

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WODACK ELECTRIC TOOL CORPORATION, 43 S. Jefferson St., Chicago, Ill.

CURRENT WELDING LITERATURE

(Continued from page 47)

PRODUCTION OF OXYGEN FROM THE AIR, by D. B. McCloud—A short, practical treatise on the nature of Oxygen, Oxygen Production and Supply, and the operation of the Air Liquefaction Process for producing Oxygen from the Air.—Railway Purchases and Stores, November.

SCRAPPING STEEL CARS WITH THE CARBON ARC, by H. E. Dralle—Three Methods of Dismantling Steel Cars Are Described. Description of a Test to Determine the Cost of Scrapping Steel Cars. Shows Total Cost $6.75 per car. Description of Electric Equipment Use and Plant Layout.—Railway Purchases and Stores, November.

SHIP SCRAPPING WITH OXY-ACETYLENE—Use of cutting torch in breaking up the battleship Maine. Ratification of the Five-Power Naval Armament Limitations Agreement calls forth a more extensive ship scrapping program. A score or more ships must be completely demolished so that neither the ships nor parts of them can be used again for combat purposes. Procedure include cutting up of big guns. 60% of the vessel's weight represents heavy steel scrap, and 10% light steel scrap.—Iron Age, November 15.

HEALTH HINTS FOR WELDERS AND METAL CUTTERS—No welder can afford to take chance with his eyesight by welding without goggles, which prevent eye strain and protect eyes against flying particles of metal and slag. In electric welding, gloves and shields are also necessary. Plenty of sleep is a great relief to the eyes. When alloys are welded ventilation is a necessity. Respirators should be provided if much cutting is done on painted metal, or galvanized metal. Welding and cutting are not unhealthy, but ordinary precautions should be observed.—Industrial Gases, London, September.

A NEW FIELD FOR OXY-ACETYLENE WELDING—How a well contractor installed oxy-acetylene welded casings in two artesian wells. The installation proved both cheaper and stronger than the conventional type of screwed joints used for these casings.—Industrial Gases, London, September.

THE HANDLING OF COMPRESSED GASES—No person should ever undertake to compress acetylene unless he understands fully the properties of the gas and knows exactly what is permissible to do and what he must carefully avoid doing. Temperature must be kept as low as practicable. Acetylene must not be stored in empty tanks, nor should acetylene tanks be used to store any other gas.—Industrial Gases, London, September.

WELDING, CUTTING AND BRAZING PRACTICE, by David Baxter—Description of a simple butt weld on mild steel, taking the novice through all the operations, from preparation of the material to the finishing and straightening.—American Garage and Auto Dealer, November.

BRONZE-STEEL WELDS, by George F. Comstock—A study of bronze welding rods for metallic-electrode arc-welding on rolled soft steel. When no phosphorus was present in the rod the boundary between the steel and bronze was sharp, though some bronze-filled cracks appeared in the steel. The addition of 1 per cent phosphorus resulted in a distinct layer of alloys between bronze and steel.—Iron Age, November 22.

TALKS ON AUTOGENOUS WELDING—History of autogenous welding. Actual state of autogenous welding. Industrial metals and alloys considered from the welder's point of view. Practical lesson on expansion and contraction in welding. Examples of heat effects on steel, cast iron and aluminum. The welding flames. Different methods of making welds. Defects and qualities of welds.—Revue de la Soudure Autogene, Paris, October.

OXYGEN-HYDROGEN DIGEST—Publication of the Gas Products Association. "Industrial Applications of Welding and Cutting" shows the possibilities for further extension of the use of these processes. "Rules for Safe Handling of Cylinders" cover the handling of Oxygen, Acetylene and Hydrogen cylinders. These rules aim to prevent waste of gas and damage to cylinders as well as accidents.

CAST IRON WELDING BY THE OXY-ACETYLENE PROCESS, by T. C. Fetherston—120 page book, published by Linde Air Products Company, New York. Contents: Nature and Properties of Gray Cast Iron; The Application of Welding to the Handling of Cast Iron; Equipment for Cast Iron Welding; Preparation of Work for Welding; Preheating; Welding; Annealing; Finishing; Testing Welds; Estimating Welding Costs; Some Typical Cast Iron Welding Jobs; Practical Problems in Cast Iron Welding. The treatment of the subject is very thorough and practical and is well illustrated by photographs and diagrams. Good type selection and heavy paper make the book easy to read and durable. It is bound in heavy paper board. Marginal notes make it easy to locate information on the various topics and an index at the end adds considerably to this ease of reference. The book is an excellent exposition of the accepted practices in welding iron castings.

ELECTRIC WELDING OF FROGS AND CROSSINGS, by H. R. Pennington and R. E. Kinkead—Discussion of the growing field of usefulness of the arc-welding process for reclamation work. Economy is said to depend upon time the welded material stays in service. Available data varies widely. Savings are estimated at half the cost of a new piece. Comparison with gas welding. Equipment necessary.—Railway Purchases and Stores, December.

WELDING SHEET METAL EXPLAINED FOR THE SHEET METAL CONTRACTOR—Welded joints compared with riveted and lock seam joints. The various welds explained. Where they are used. An outline of equipment needed for this work. Severe tests of welds.—Furnaces and Sheet Metals, December.

WELDING ALL-STEEL AUTOMOBILE BODIES, by J. W. Meadowcroft—Description of equipment employed by the Edward G. Budd Mfg. Co., of Philadelphia, handling 500 tons of steel daily for one product. A system of apprenticeship training is used and men are advanced from time to time in accordance with their ability. Acetylene welding, arc welding and resistance welding are all used. The welded body is practically a one-piece body.—The Iron Age, November 29.

APPLICATIONS OF ARC WELDING TO SHIP CONSTRUCTION, by E. H. Ewertz—Tables showing time required for various types of electrically welded joints as compared with riveted construction. Conversion table for time required using different sizes of welding rods. Time required for filling holes.—Marine Engineering, December.

OXY-ACETYLENE TIPS—Monthly publication of Linde Air Products Company. The December number contains: Largest Single Piece of Equipment Ever Constructed by Oxy-Acetylene Welding; Reducing Battleships to Scrap with the Oxy-Acetylene Cutting Blowpipe; Standardization of Cost Finding Methods; Frames for Wire Fence Gates Fabricated from Pipe by Oxy-Acetylene Welding; Bent Structural Members of a Ship Heated for Straightening with the Welding Blowpipe; Increasing Production Seventy-five Per Cent; Sheet Steel Trailer Buckets Fabricated by the Oxy-Acetylene Process; Welded Range Boilers Assure Satisfied Customers; One Man Reclaims a Ton of Castings per Day.

PRACTICAL APPLICATIONS OF GAS WELDING, by E. A. Whitaker—A review of some of the important uses of the torch, including repair and construction of iron and steel parts, repairs to iron castings, aluminum welding, copper, brass and bronze welding, and cutting. Descriptions and illustrations of a few typical jobs.—Acetylene and Welding Journal, London, November.

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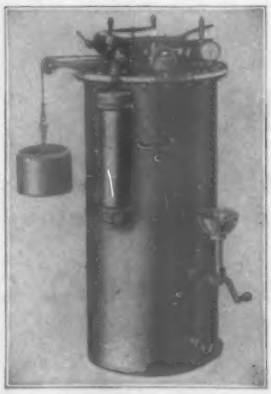

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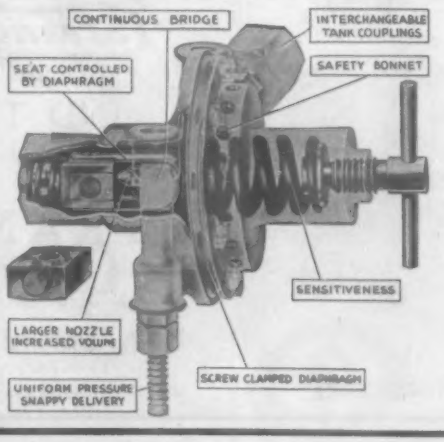

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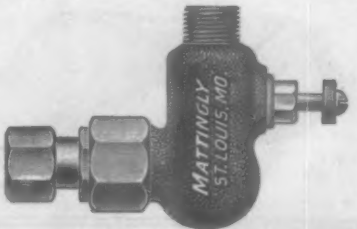

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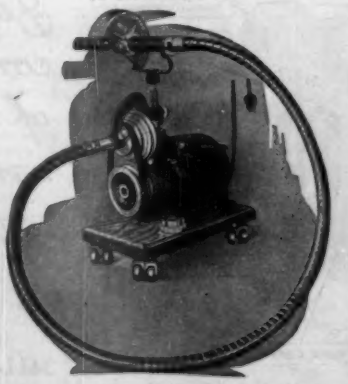

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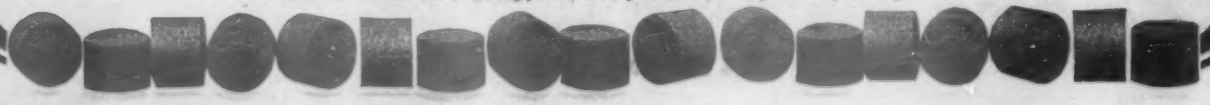

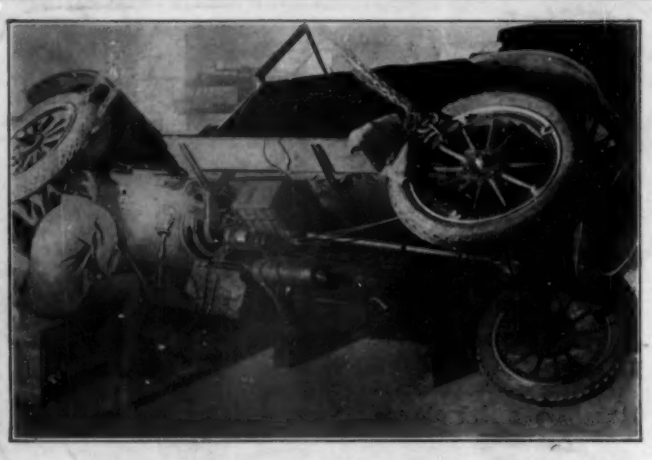

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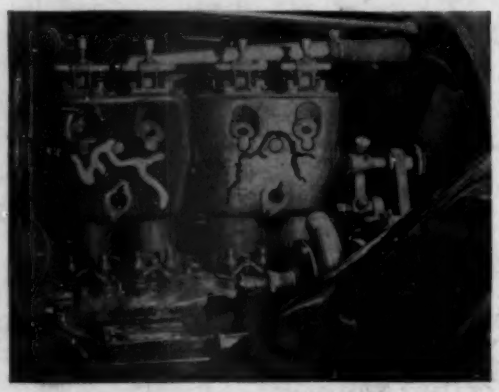

CRACKED WATER JACKETS

CAST IRON FLY WHEEL 14 FT. DIAMETER

There's no uncertainty about ALTERNARC Welding

Are You Welding

Automobile frames or are you just putting a plate on and tacking around?

Alternarc welds frames overhead or anywhere.

Are You Welding

malleable iron or sort of brazing or soldering it?

Alternarc welds malleable iron.

Are you welding cracked water jackets and crank cases without dismantling?

Are you Welding large machine jobs in place **that cannot be pre-heated or annealed?**

Alternarc will weld it.

If you will write for our booklet Alternarc or Instruction Handbook you might learn something from the experience of others.

Electric Arc Cutting & Welding Co.

152-56 Jelliff Avenue,
Newark, N. J., U. S. A.

PORTABLE
DURABLE
FLEXIBLE

APPARATUS